TECHNOLOGY DEPARTMENT

DECEMBER, 1947

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Plant Engineering

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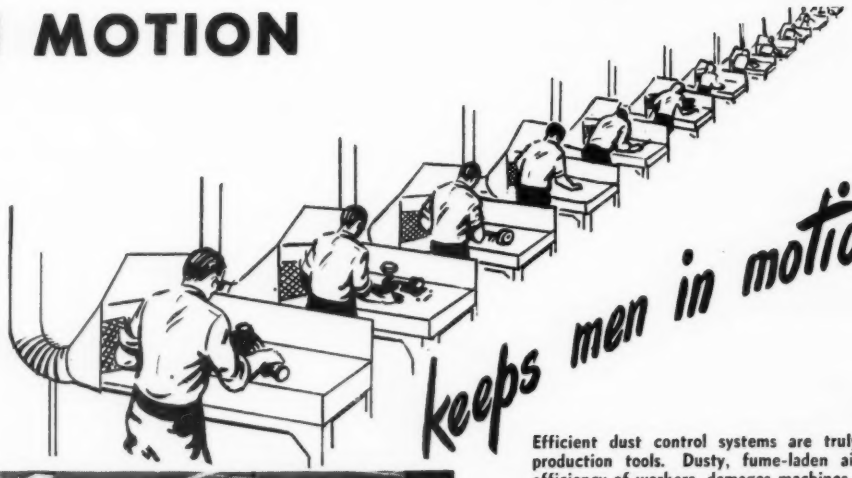
The magazine that helps plant engineers with their everyday problems

AIR IN MOTION



keeps men in motion . . .

Efficient dust control systems are truly important production tools. Dusty, fume-laden air dulls the efficiency of workers, damages machines, motors and bearings, curtails production.

In the plant of a noted chain and forging firm, for example, a KIRK & BLUM installation which replaced an old, inefficient system improved working conditions to such an extent that it brought this comment from an official: "Our workmen can now work full time . . . this means added production for them and the company as well."

The illustration at the left shows a KIRK & BLUM system for castings grinding at the bench. Dust, sand and chips are removed as fast as produced. Note particularly turntable in center of bench which revolves work to operator so that he may work continuously. This results in better dust control . . . less lost motion.

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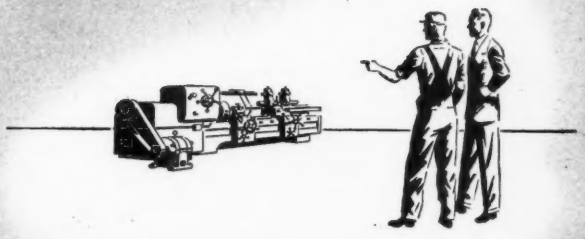
KIRK AND BLUM
DUST CONTROL

AN ORGANIZATION OF ENGINEERS & MECHANICS

Right: A Kirk & Blum Down Draft Dust Control System in the plant of The Monarch Machine Tool Company, Sidney, Ohio.

Ask your repairman what he thinks of Crocker-Wheeler **protected-type** motors



Here is an easy test of motor quality: Ask the man who has to keep your motors in running order.

You will find that the repairman has a very high regard for Crocker-Wheeler motors BECAUSE *he has had so few of them to repair.*

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- **WHERE THERE IS DRIPPING LIQUID**
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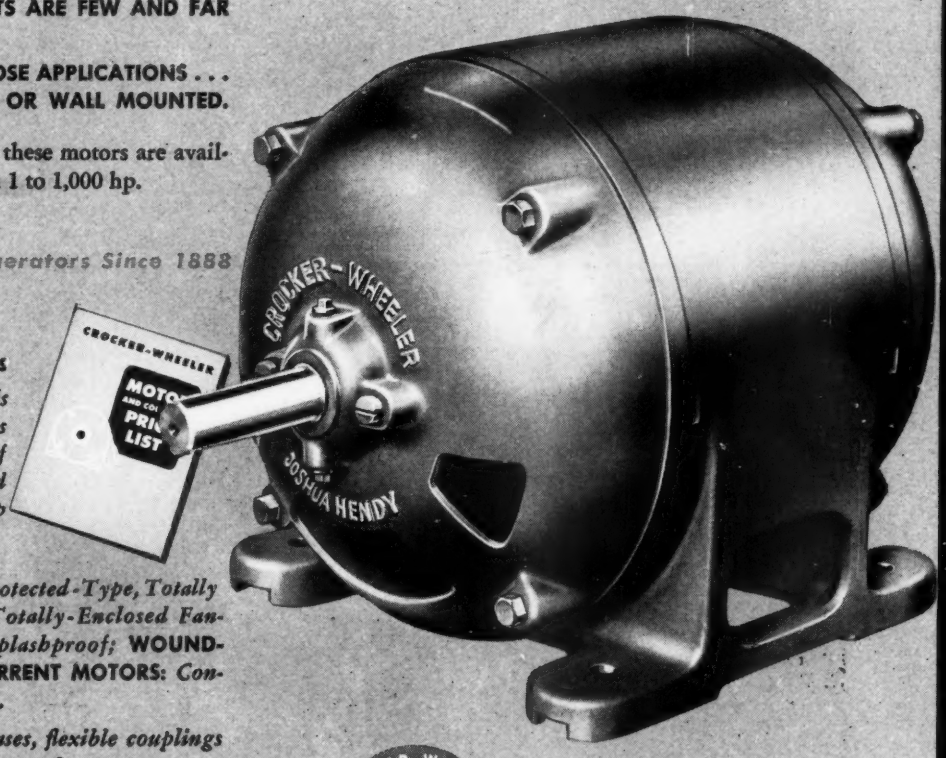

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Letters from the Readers

This section is for open discussion of: any topic of interest to, or, in the sphere of the plant engineer; pertinent comment on articles published; and suggestions, criticism or commendation. Let the quips fall where they may. Material selected for publication will be paid for and, upon request, name and company connection will be omitted.

Beauty Shops for Sprinkler Systems?

. . . Yes, sprinkler systems need regular maintenance as you point out on p. 58 of the November issue. More than that however, they need a bit of thought on planning and design. Why do they always have to stick out like a sore thumb and ruin the appearance of every room they are installed in? Not all of them are installed in barns and warehouses. Many are in offices and structures where a great deal of time and effort has been spent on layout and design and where appearance is a considerable factor. Why not put some thought on beauty treatment for this utilitarian device? Would that be gilding the lily? M. M.

Who Does the Researching?

WHY THE undue emphasis on research? In the first headline of the first issue research is given a big play. Of course it's modified to some extent later but it still leaves the impression that research is No. 1.

In this writer's opinion the best research department is still the mass of people and not a chosen few who are paid to make a business of researching. The writer is not opposed to research departments, but he believes that the present tendency is to carry research too far and to place it on too high a pedestal.

Most, if not all, of the great inventions of all time have come from comparatively small men, and that is where they will very likely continue to originate. Most of the large industrialists of today are leaning heavily on their practical workers for suggestions and are paying for suggestions that are accepted.

These suggestions, in the writer's opinion, earn much more for the manufacturers than do the results of paid research departments—on the whole. The words, on the whole, were added to the preceding sentence because there very likely are exceptions.

Let us therefore continue to encourage the small man and refrain from overwhelming him with all this talk about the mightiness of research. In talking with young men about their work the writer finds that most of them feel that they are not equipped to develop their ideas. They feel that only the large concerns can do the future developing because ideas have of necessity become so very complex. That, this writer contends, is not true.

There is no limit to ideas, simple as well as complex. That is, the limit is infinity, which means that there is plenty of room for everybody. Thus if every human in the world should come forth with a hundred new ideas next year that would be, roughly, two hundred billion ideas, which is much less than one millionth of one per cent of infinity. It is merely the beginning.

So, young man, don't allow yourself to be discouraged. There are so many possibilities that your own hundred ideas can be easily worked out by you alone in your own work shop even though it may be small. The chemists and other paid researchers on the pedestals can go ahead in their spheres, but be assured that you have your own sphere to work in, and it is a very very large, limitless sphere.
Newark, N. J. W. F.

Would YOU Like to Be an EDITOR?

THERE IS an opening on the PLANT ENGINEERING editorial staff for a man who has a good personality and common sense, who likes to meet people, travel and write. He does not have to be a gifted author but must be able to write clear and concise English. He should have: an engineering education although not necessarily a degree, at least 4 to 6 yrs practical experience as a plant engineer; and, if a veteran, preferably service as post engineer or in air corps maintenance. If you qualify and are interested in a congenial occupation write The Editor, PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago, Illinois.

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New Products and Methods

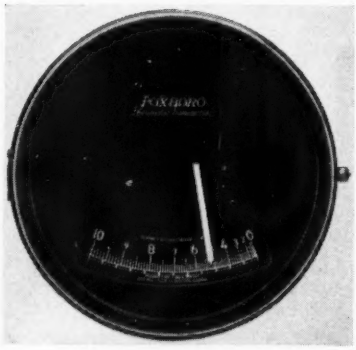
What's New? American industrial superiority is based upon doing things easier, faster and better. Here industrial ingenuity is summarized for your quick review. If you want additional information, have questions on specific applications, use the no obligation, no postage, "Mark, Clip and Mail" postcard between pages 18 and 19 and 58-59

ITEM NO. 1

Pneumatic Transmitter

A new Transmitter, identified as Model 42, is announced by The Foxboro Co. for use in the pneumatic transmission of industrial process measurements such as flow, static or differential pressure, liquid level, temperature or humidity. It is an indicator-type instrument, available with either an eccentric or concentric scale, both being designed for quick and easy reading.

The Model 42 Transmitter is essentially an improved design of the previous Foxboro Transmitter, but the changes are sufficient, both in number and importance, to qualify it as a new instrument. The most important of these is a completely new transmitting element, which is exactly duplicated in the receiving instrument. Since the transmitting and receiving mechanisms are exactly matched and perfectly linear in calibration, improved accuracy in transmission is the inevitable result. Simplified calibration is another advantage gained in the new design.



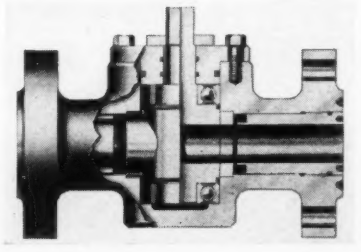
ITEM NO. 2

Plug Valve

A new, quick-opening high pressure fluid control valve, known as the "LJS Plug Valve" is now in production at Johnson Foundry and Machine Co. LJS valves feature a straight, non-tapered plug that requires no lubrication and is suspended top and bottom on sealed ball bearings which take the thrust radially. This plug is the only moving part. A quarter turn opens and closes valve at high pressures and temperatures, requiring very little torque.

"Floating" seats of hardened steel are ground and lapped for a precision fit with plug for perfect seal at each port. Plug does not touch body at any point, keeping friction to a minimum. Behind each seat, an expansion gland forces seat tightly against plug with just enough "give" to prevent plug from ever siezing or sticking. These glands are held in place by replaceable steel retainer sleeves. At no time does fluid ever come in contact with valve body: wear can only result from longitudinal flow of fluids. All wearable parts (plug seats, glands, sleeves) may be replaced right on the job without use of special tools.

Straight line flow offers no restrictions, creates no turbulence and effectively resists corrosion, heat, abrasion and product contamination. Flange and screw type plug valves are available in ferrous, non-ferrous and special metals for every type of industrial use.



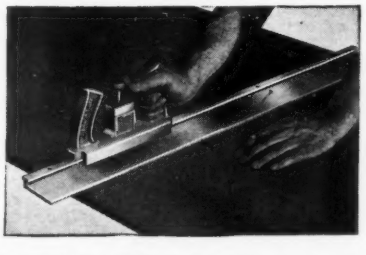
ITEM NO. 3

New Belt Cutter

A new type of belt cutter has been developed by the Flexible Steel Lacing Co. that makes it a simple job to cut belts up to 60 in. wide and 1⅛ in. thick. The new cutter will be called the No. 300 Alligator Wide Belt Cutter.

The No. 300 cutter is made up of two elements—the head that carries the blade and a T-shaped base or guide rail.

To use the cutter as shown in the illustration all that is necessary to do is to square the base up with the center line of the belt. The base is then nailed to the belt and the cutter is pushed across the belt. Each cut is made about ⅛ in. deep and the screw is then turned to lower the blade another ⅛ in. With several rapid cuts a belt can be cleanly and squarely cut.



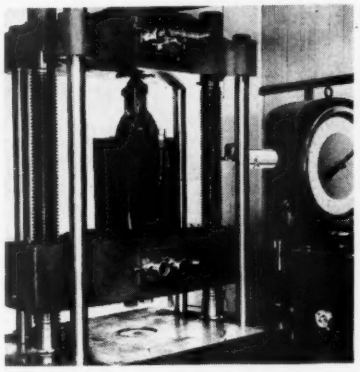
The blade consists of a long, thin, narrow strip of steel sharpened in a V shape. It is held in a slot in a vertical position in the head and vertical adjustment is accomplished by means of a screw.

The base is made in four lengths for 24 in., 36 in., 48 in. and 60 in. belts. Each base is 4 in. longer than the width of belt on which it is designed to operate. This is to give sufficient guide to the head when the blade is drawn across and clears the outer edge of the belt.

ITEM NO. 4

High-Temperature Pipe Clamp

In the field of high-temperature piping it has been necessary to use clamps that were of special design and custom made. Grinnell Company, Inc., has undertaken to supply the demand for high-temperature pipe clamps in seven sizes from 4 in. through 16 in. with a commercial clamp made of chrome vanadium steel as a one-piece drop forging and equipped with a U bolt of the same material. These are expected to meet the major portion of high-temperature pipe clamp requirements at temperatures up to 1000 F. without a high cost penalty.



Load ratings of the clamps for the various pipe sizes have been established after an exhaustive series of tensile strength tests (see illustration) in which the clamps were pulled to destruction to determine their ultimate breaking strengths. On the basis of the results of these tests conservative maximum recommended load ratings have been established for their use on piping at various elevated temperatures in accordance with the Code for Pressure Piping.

The accompanying illustration shows a 14 in. Fig. 224 pipe clamp set up in a tensile testing machine prior to being pulled to destruction at 66,300 lb load.

ITEM NO. 5

Chain Hoists

The Chester Hoist Co. announces a new line of differential chain hoists made to meet present day demands of severe punishment, high rate safety and within a normal price range.

The construction features are full

New Products and Methods

weight accurately cast sheave wheels, high tensile malleable iron frames with reinforcing ribs, drop forged heat treated hooks, special analysis hoist chains precision made to fit sheave pockets, thereby assuring smooth, free operation—lower hook mounted on ball thrust bearing for easy alignment of loaded chain to upper pocketed sheave and swiveling of load.

It is a hoist of exceptionally few parts therefore lighter in weight without sacrifice of any strength, and more portable.

It holds its load at any point, will not self-lower—making it ideal for use by garages, small firms and for use on trucks. Made in ¼, ½, 1 and 1½ ton capacities.

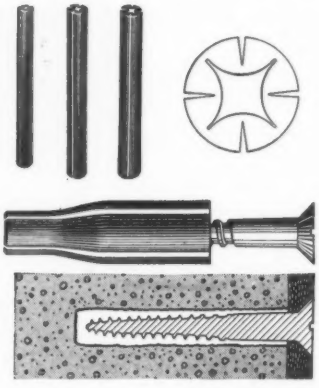
ITEM NO. 6

Screw Anchor

This plastic expanding screw anchor was announced recently by Holub Industries, Inc. It is designed for use with standard wood and lag screws in any material from plaster, concrete and brick to bakelite, glass and rubber.

The features, as listed by the manufacturers are: extremely high holding power as shown by tests conducted by Pittsburgh Testing Laboratory; resistant to water, weather and acids; resistant to age and corrosion, will not rot; inexpensive; tough material with high impact strength; good electrical characteristics; easily cut to any required length; no special tools needed to use the anchors.

The anchors are available in seven sizes for use with from No. 5 to No. 20 wood screws and up to 5/16 in. lag screw.



Is there a piece of equipment described here that will solve a big problem in your plant? Do you need more information on it in a hurry? Phone or wire prepaid, The Editor, PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago. Tel. Harrison 0824. Your request will be rushed to the manufacturer's nearest branch office or to his headquarters

ITEM NO. 7

Intake Cleaner-Silencer

Development of a new intake air cleaner-silencer for use on internal combustion engines, compressors, or blowers has just been announced by Burgess-Manning Co. Designated as Series ICS, these units are available in pipe sizes from ¾ in. to 6 in.

It is pointed out that design of these new units is completely different from similar units previously available. The nonferrous filter element is quickly removable for cleaning or replacement without the necessity for taking off screws or covers. Sturdy, foolproof snaps secure it in place and are quickly released when filter removal is necessary. The snaps are attached to the heavy steel body of the unit to prevent loss.

The body of the Series ICS Cleaner-Silencer contains a scientifically designed surge chamber to smooth the flow of intake air and remove noisy pulsation. Actual performance tests show that intake noise is effectively reduced below the general noise level.

Series ICS Cleaner-Silencers can be installed indoors in any position—horizontal or vertical—without loss of efficiency. When necessary to install one out-of-doors, the filter should be down to shed rain and snow.

ITEM NO. 8

Fluid Drive Elevator

When the Warsaw Elevator Co. introduced its new "Gyrol" fluid-drive elevator last month it came up with an outstanding elevator development. Basically, this new fluid coupling device is identical with that used in some automobiles, and it makes possible a number of economies.

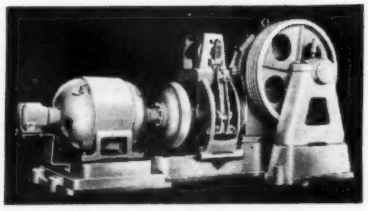
A less powerful motor is required. This is due to the fact that the motor starts under no load. When the car switch is closed, the motor starts and gains practically full momentum before the fluid coupling takes hold. No starting current is required and the power costs are materially lower.

More important, is the simplicity of the electrical control system. The standard control panel for electrical elevators is a highly complex arrangement of heavy-duty automatic switches, each switch controlling a single stage of acceleration and deceleration. This is necessary so that jerky starting and stopping will be eliminated.

With the fluid drive, however, only a single switch is required for upward travel and another for downward travel. Only these two switches require service and maintenance. Without fluid drive, there would be a dozen or more to service, depending on the size of the panel.

Not only is this arrangement simpler and easier to service, but it takes a great deal less space . . . so that elevator machinery rooms can be made smaller, saving space for other purposes.

One of surprising things about the "Gyrol" fluid drive is that hairline leveling is obtained with "single speed" equipment. Company engineers have worked out a unique switching arrangement in conjunction with electronic controls, resulting in one of the



simplest and most satisfactory arrangements available. In some installations, say Warsaw engineers, this leveling system has given uninterrupted service for more than seventeen years without a tube replacement.

While it is difficult to state what over-all saving is possible with "Gyrol" fluid drive elevators, Frank McKee, Warsaw Sales Manager, stated that in general, savings of well over ten per cent are estimated on installation alone.

The new units are now in full production and early delivery can be made through Warsaw's new nationwide dealer set-up.

ITEM NO. 9

Anti-Rust Paint

Speco, Inc., has announced that Rustrem anti-rust paint is now available in aluminum as well as in black.

This new paint, according to the manufacturer, can be applied right over rust without brushing or scraping. It is reputed to immediately penetrate the rust layer, render it inactive and seal the surface against further rusting.

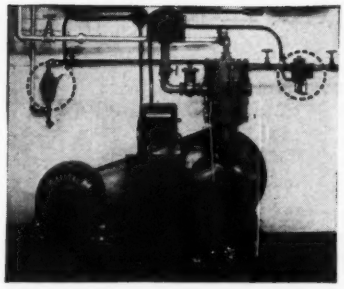
Other features claimed are high resistance to chemical action and immunity to climatic changes.

It is especially recommended for use under water, in salt water, or in locations where dampness and moisture are ever present. Rustrem Aluminum can be painted over with any high quality paint or enamel.

ITEM NO. 10

Solenoid Valve

In further developing the compressor control announced some time ago, the Johnson Corp. is now utilizing the company's new direct operated solenoid valve. This now provides everything necessary for complete automatic control of the water supply to water cooled



compressors—protects against any dangerous overheating and at the same time effects considerable water savings.

This solenoid valve is a direct operated type—has no auxiliary pistons. It is a heavy duty valve in all respects, and was developed to make the simple design and quick opening of solenoid valves available for a really practical range of services.

It handles temperatures up to 400 F and in some sizes will operate under differential pressures up to 150 lb. It is being used very successfully on boiler feed lines, and for a wide variety of automatic flow control applications.

In the compressor control, this solenoid valve is used to admit water to compressor whenever the regulator on storage tank calls for more pressure. The compressor itself is not started until water flows through the compressor and completes an electrical circuit with an electrode mounted in a holder on the discharge line.

If water doesn't flow for any reason, compressor will not start, or if operating, will stop immediately. When receiver is satisfied, compressor is stopped and the solenoid valve shuts off water at once.

This Johnson control can also be furnished for use with unloading compressors. In all cases it protects against the compressor operating without cooling water, and yet prevents unnecessary waste of water.

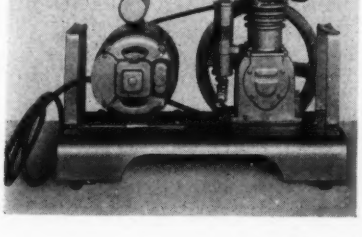
ITEM NO. 11

Air Compressor

Some users often need compressed air power at various scattered locations and these jobs vary so much as to location and distance that air pipelines and hoses attached to a central compressor are not practical. Furthermore, they result in losses in air volume and pressure. Lightweight, portable air compressors have only partially solved the problem. For the usual lightweight, portable air compressor was built to provide low air pressure and high air volume, with the result that air pressure was too low for certain types of work.

To meet this need more satisfactorily, American Brake Shoe Co., Kellogg Division, has developed the new, small, lightweight A-140-XS. This air compressor is carried easily from place to place. Yet it delivers 3.3 cfm displacement on continuous operation at 130 psi. This is sufficient for inflation of tractor and truck tires, and greasing. Moreover, by attaching a regulating valve when needed, pressure can be reduced for paint sprayings, insecticide spraying, and similar uses.

The A-140-XS includes a standard compressor with safety valve and pulsation chamber, and ½ hp electric motor, mounted on a rugged base that is equipped with two large handles for easy carrying.



Do you want more information on this equipment and its application? Use the no obligation, no postage card between 18 and 19 and 58-59

ITEM NO. 12

Angle Type Strainer

A strainer has been designed with an angle construction so that it may be installed directly upon the unit that it is to protect.

This is a particularly effective piping practice, as the strainer can be in-

stalled when the equipment is first installed, or even on the original equipment by the manufacturer, thereby saving time in handling and requiring fewer connections, fittings and piping space. These strainers are commonly used with pumping equipment and other close tolerance units.

Various types are made with the following pressure ratings: 125 lb, 150 lb, 250 lb, and 300 lb. The latter rating is particularly suitable for vapor, steam, gas or other high pressure service.

The strainer may be used at any point in a pipe line where it can serve as, or replace a right angle connection, thereby saving space and additional connections.

New Products and Methods

To provide for corrosion resistance and special flow of characteristics, strainer basket material and perforations are usually furnished to specifications as required for each installation. The body and cover assemblies are available in cast steel, semi-steel or bronze, depending upon the pressure requirement. These metals fully meet A.S.M.E. requirements for metal used in pressure vessel parts. It is announced by J. A. Zurn Mfg. Co.

ITEM NO. 14

Warns When Bearings Overheat

To warn when bearings start overheating is the function of a new automatic, multi-point bearing temperature monitoring system recently developed by the Instrument Division of Thomas A. Edison, Inc. The system is adapted both to principal equipment and auxiliaries in power generating stations, gas plants, pipe line substations, and general industrial operations. As many as twenty-four bearings can be monitored from each central control cabinet.

Electrical resistance bulbs are used. Each is only 0.215 in. in diameter and mounted in a small hole drilled in each bearing. Only the bulb tips are temperature-sensitive and, because these tips are located in direct contact with the bearing metal very close to the actual inner bearing surfaces, existing bearing temperatures and their fluctuations are sensed rapidly.

The temperature of each bearing is checked automatically every two minutes. If, when checked, the temperature of any bearing exceeds an established maximum (which may be different for each bearing), an alarm is sounded to call an attendant. The overheated bearing is identified by an indicating lamp on the central control cabinet panel.

An attendant reads the actual temperature of any bearing by plugging into the appropriate jack an electrical thermometer which is built into the central control cabinet panel. Thus, he can observe whether the temperature of a bearing is rising rapidly or slowly, can decide what action to take, and can observe the effect of this action.

A modification of the system not only sounds an alarm at one established temperature, but also automatically

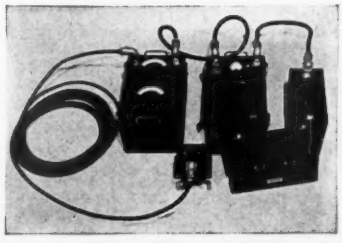
ITEM NO. 13

Measures Thickness from One Side

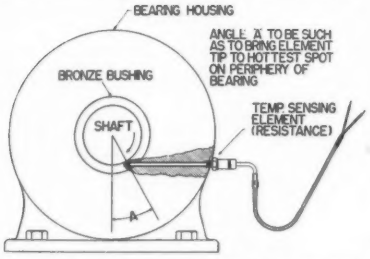
A new precision instrument for the measuring of corrosion and wall thickness from *one* side of metallic surfaces has been announced.

It is designed for the nondestructive inspection and testing of metallic containers, vessels and piping while in service. Vastly increases the scope of inspecting and testing boilers and pressure vessels. Measures thickness within 3 per cent of actual thickness.

In its practical form it combines a 4-electrode probe, a small 6-volt battery, an electronic voltmeter and power supply for measuring the low-voltage output from the probe, and interconnecting cables to permit probe to be moved about at a distance from the metering equipment. Measures steel thicknesses from 0.125 in. to 2.250 in. Portable and weighs 55 lb. It is announced by Scott Electroflux Co.



New Products and Methods


BEARING HOUSING
ANGLE A TO BE SUCH AS TO BRING ELEMENT TIP TO HOT TEST SPOT ON PERIPHERY OF BEARING
BRONZE BUSHING
SHAFT
TEMP SENSING ELEMENT (RESISTANCE)
A

shuts down the machine if a second, and higher, established temperature is reached. This is particularly useful at unattended substations or pumping stations. With the modified system, the initial alarm can be transmitted to a central point any distance away, and an attendant may be sent to take corrective action. Should the attendant arrive before a dangerous temperature is reached, he may be able to prevent a shut-down. Should he not arrive in time to take corrective action, the equipment is stopped automatically to prevent damage.

In either system, checks of the actual temperature of each bearing may be made any time at the control panel, on which facilities are also provided for the checking and testing of all circuits and alarms.

ITEM NO. 15

Cone-Drive Speed Reducers

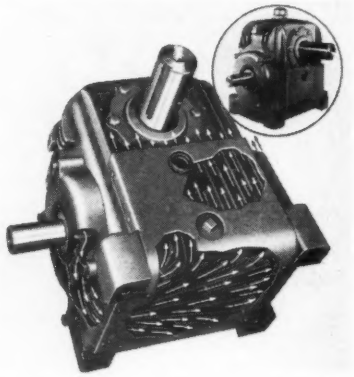
A line of fan-cooled cone-drive speed reducers is available in the following sizes:

Center Distance (inches)	HP Rating @ 1750 rpm 5:1	60:1
4	19.8	2.54
5	37.0	4.75
6	59.1	7.87
8	119.2	16.20

The announcement reveals that the standard heavy-duty pinion-under Cone-Drive speed reducers were originally designed with applicability to fan cooling in mind. Thus, the basic units of the new fan-cooled reducers are identical with the non-fan-cooled models of this type.

Horsepowers given above apply equally to mechanical or thermal ratings and have not been increased over the mechanical ratings specified for equivalent size non-fan-cooled units. The various reducers are available in standard ratios of 5, 10, 15, 20, 25, 30, 40, 50 and 60 to 1. The 5, 6 and 8 in. reducers are also available in a 70:1 standard ratio. All models are pinion under (FHU—heavy duty).

Removable shields direct the fan impelled air over the finned lower portion of the speed reducer housing in such a manner that equalized air-flow is obtained at all points of the housing requiring cooling. The fins are so located and shaped as to guide the streams of air for maximum cooling



efficiency. The use of removable shields makes possible two important operating factors. 1. Removal makes the entire housing accessible for cleaning when required (important in locations where air is laden with dust). 2. The impeller and shields may be removed if it is desired to operate the reducer in another location without fan cooling.

The shields are removed by merely unfastening a number of screws which attach them to the housing. The fan is attached to the standard pinion shaft by means of a set screw and key, using the extra long keyway standard on these reducers. They are announced by Michigan Tool Co.

ITEM NO. 17

Non-Marring Hammer

An important new improvement has been made in the Kant-Mar hammer, one of a line of Schmidgall Products. Tips of the Kant-Mar are made of a precision turned special aluminum alloy called "Velv-Alum," easily replaceable after hard wear. Velv-Alum is a new material sufficiently tough to take the punishment in such jobs as in garages, machine shops, foundries, yet is safe enough so as not to mar the most delicate surfaces encountered in the tool room on dies, etc. Velv-Alum also reduces the chance of eye injury due to chipping, and the Kant-Mar is perfectly balanced to practically end rebound accidents.

The handle is of selected grade hickory. Head has an oval hole (not round), for handle, eliminates loose handles and the consequent danger of injury.

The Kant-Mar is made in two sizes, for light and heavy duty: 8 and 32 oz, in a plain model (non-replaceable tips), and in the same sizes in a model and with replaceable tips. Additional 8 and 32 oz tips may be obtained separately.

ITEM NO. 18

Test Clamp

This new test clamp meets the rapidly growing need of production and maintenance men for a sturdy, heavy-duty, shock-proof clamp to be attached to ends of cords on portable equipment such as floodlights, sanding machines, floor polishers, saws, dust collectors, furnace cleaners, drills, welders, etc.

It is said to supply a vise-like grip on flat or round objects up to 1 in. diameter or width, such as: fuse clips, meter or motor terminals, cables, busbars, lugs, screws, battery posts, etc. Once applied it "stays put."

A slight twist of the large fingertip knob exerts tremendous pressure. It will carry up to 150 amps continuously and 200 amps intermittently. Solderless lug accommodates No. 2 wire minimum; No. 0 wire maximum and swivels around the clamp, permitting wire or cable to clamp in a natural position. It is now made by Trico Fuse Mfg. Co.

ITEM NO. 19

Converting Rotating to Reciprocating Motion

A simple and efficient means of converting high rotating speeds into slow reciprocating motion, built as an integral unit on anti-friction or plain bearings, depending on power requirements is possible with this new epicyclic drive. Test data on compressors and hydraulic pumps show greater efficiency than with more conventional methods of belting or gearing. Design of the drive permits considerable flexibility in both speed and stroke, making possible the use of built-in or direct drive input power where desirable in streamlining or packaging. Multiple units of different gear ratios and strokes may be mounted on a common power shaft.

One geared epicyclic unit used in conjunction with a master connecting rod lends itself to radial design in

Do you want more information on this equipment and its application? Use the no obligation, no postage card between 18 and 19 and 58-59

ITEM NO. 16

Electronic Speed Control

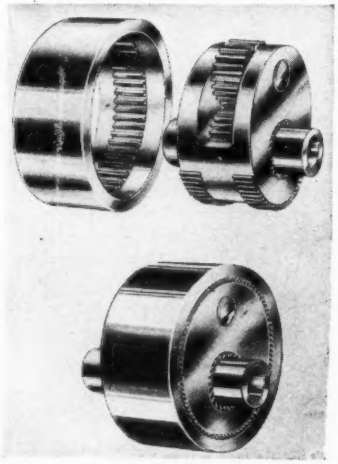
For use in controlling speed of the Company's magnetic drive, the "Regutron" illustrated provides excitation and speed control of boiler draft fans and centrifugal pumps, compressors and blowers on which the magnetic drive is used.

It rectifies 3-phase supply current to energize magnetic drive, and adjusts value of current to hold operating speed of load to within plus or minus 1 per cent of selected speed. Speed of the load is selected by automatic or manual positioning of a small potentiometer. Other components of control system guard against effects of overvoltage, undervoltage, short-time power failure, improper operation of tubes or amplifier.

Since excitation current from the Regutron is balanced against the voltage from a tachometer generator belted to the load, speed is held constant despite variation in prime mover speed or changes in load or voltage. It

is announced by Electric Machinery Mfg. Co.

Is there a piece of equipment described here that will solve a big problem in your plant? Do you need more information on it in a hurry? Phone or wire prepaid, The Editor, PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago. Tel. Harrison 0824. Your request will be rushed to the manufacturer's nearest branch office or to his headquarters

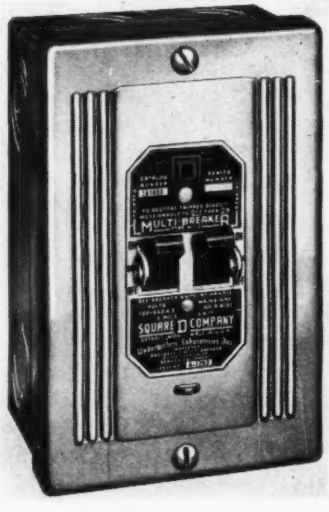


either vertical or horizontal positions, the unit itself replacing the master rod bearing. Where synchronous speeds are not required, rolling members may be substituted for the gears, offering greater manufacturing economy. Is announced by American Brake Shoe Co.

ITEM NO. 20

New Type Multi-Breaker

A new 1 and 2-pole Multi-breaker, ideally suited for serving lighting appliance and small motor circuits in offices, factories and farms has been introduced by the Square D Switch and Panel Div.



This new Multi-breaker features a thermal-(coilless) magnetic trip which provides instant tripping on short circuits but which holds on harmless overloads. The magnetic trip functions in 1/50 to 1/100 of a second, even on minor short circuits. This magnetic trip feature is combined with a thermal bimetal element which provides time-delayed tripping on moderate overloads.

These new breakers are furnished in 1947 N.E.C. ratings of 15, 20 and 30 amp —120/240 v, a-c, flush or surface types. With groundable insulated neutral, they are Underwriters' approved as service entrance equipment as well as for general use on lighting and appliance circuits.

ITEM NO. 21

Aluminum Industrial Roofing

Production of a new, high-quality aluminum roofing material for industrial use, to be called Alcoa Industrial Roofing, was announced recently to the building trades by Aluminum Company of America.

The new product is a lightweight, heavy-duty specially-formed material, developed by Alcoa research to meet the demand of industrial builders for an aluminum roofing and siding specifically adapted to factories, warehouses, storage depots, hangars, and similar structures. Alcoa states that the new Industrial Roofing will carry heavy loads and meet the exacting requirements of building codes.

Combining high strength, exceptionally high resistance to industrial atmospheres, minimum maintenance and reduced roof load, Alcoa Industrial Roofing will have a covering width of 32 in. allowing for a side lap of 1½ corrugations. It will come in standard five-foot through twelve-foot lengths, 0.032 in. thick.

Alcoa also announced that industrial aluminum siding, of the same alloy and lengths as the roofing, is going into production at the same time. The siding will have a coverage of 32 in. and will meet code requirements for siding materials.

It was stated that Alcoa Industrial Roofing and Siding will be offered for sale through normal channels of distribution. All necessary fittings and accessories such as ridge roll, flashings, rivets, nails, straps, etc. will be supplied with roofing and siding.

Alcoa engineers reveal that the new product meets safe load requirements

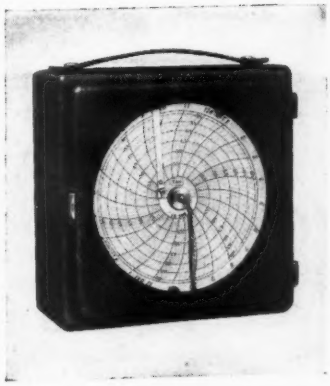
New Products and Methods

(using a factor of safety of 2), ranging from a 30-lb per sq ft uniformly distributed load on 6 ft 5 in. purlins up to a 105-lb load on 3 ft 6 in. purlins. The new material has excellent weathering qualities, and paint or roofing preservatives are unnecessary. The light weight of aluminum permits erection with a smaller crew, and rapid installations can be made on all types of industrial buildings.

ITEM NO. 23

Small Temperature Recorder

A miniature-size temperature recorder, designed for use in the many applications where a shock-resistant, easily portable temperature recording instrument is necessary, has been announced by the C. J. Tagliabue Mfg. Co. Said to resist shock and vibration



successfully, this new instrument is particularly suitable for use in operations where vibration is encountered. Because of its small size and portability, it is also extremely useful for checking refrigerating, heating and air-conditioning equipment. The instrument is available in two forms: the

(Continued on page 12)

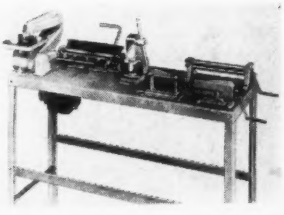
ITEM NO. 22

Sheet Metal Working Unit

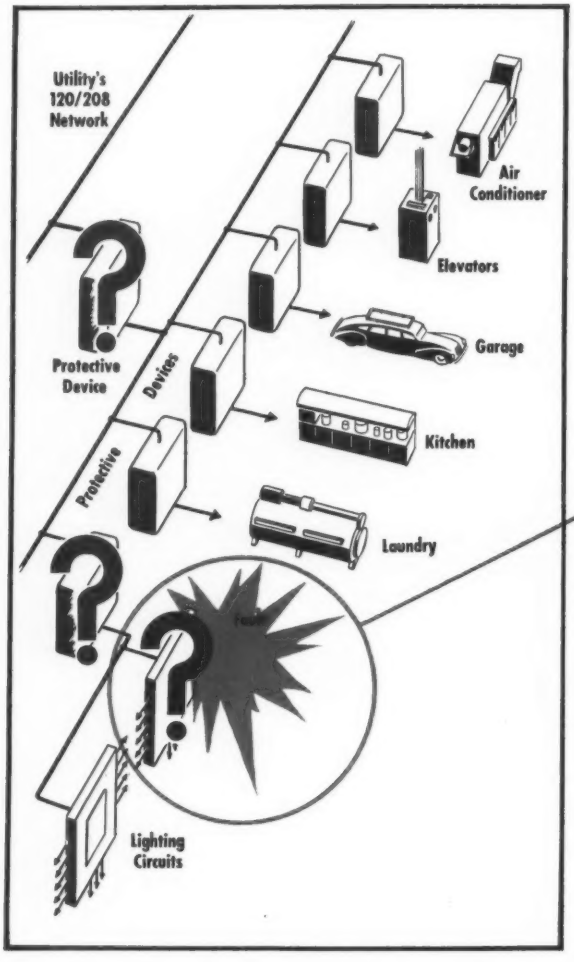
For industrial use, a completely equipped sheet metal working shop mounted on a heavy gage steel and nearly 6 ft in length is now being produced. Each tool will process up to 20 gage sheet steel.

Heavier gages of aluminum, zinc, pewter, copper, plastics and other softer materials can be worked. The complete unit includes five tools, nibbler, 12 in. slip roll, hand punch, 12 in. brake and shear.

Priced at only $217.50, the unit is a complete metal working equipment within range of modest budgets. Each of the five tools is also available for individual purchase. In their performance on medium and small work, the tools are comparable to larger equipment. Because of this fact, they have wide applications in industry both in metal working shops and experimental departments. The Berkroy unit is also well adapted to use in school shops. Full information may be obtained from the manufacturer, Berkroy Products, Inc.



COULD YOUR PROTECTIVE DEVICES..... STOP



Because of the high kva capacity of a network system, bad shorts may draw tremendous surges of current that may blast protective devices of inadequate "IC." Loss of power to all facilities may result; equipment and personnel may be endangered by flying metal and fire. G-E air circuit breakers afford adequate "IC" protection, isolate shorts at their source, and do away with the possibility—and hazard—of over-fusing. Also, all costs of replacing fuses are eliminated. Be sure to check with your nearest G-E sales representative for complete information before installing protective devices on installations fed by a network system.

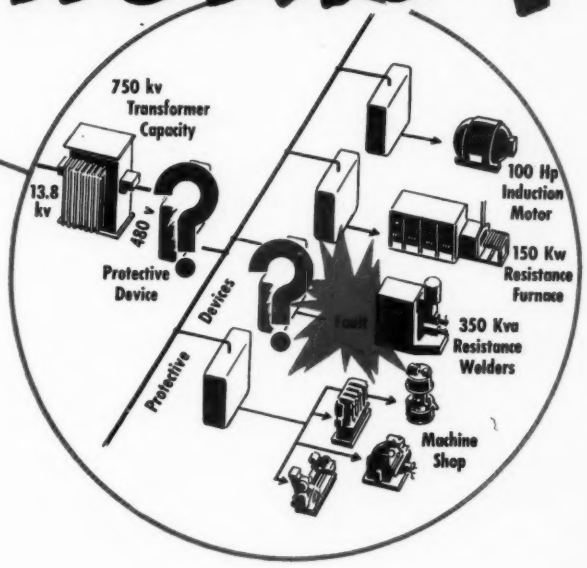
. . . PREVENT

You're gambling with production, equipment, and personnel if your protective devices have inadequate "IC." Inadequate "IC" means that the device, whether it's an air circuit breaker, fused knife switch, or oil circuit breaker, is unable to handle the full short-circuit currents available on a low-voltage system. Under such conditions devices may fail, resulting in costly power shutdowns and loss of protection, besides hazards to personnel. Be sure of your "IC." Here's how . . .

KNOW THE "IC" of your low-voltage protective devices. The interrupting capacity of a circuit breaker or other protective device is the maximum current it is rated to ***adequately*** interrupt.

BE SURE THE "IC" IS ADEQUATE to interrupt maximum short-circuit currents. Maximum short-circuit current is *not* determined by the normal load on the circuit. The total capacity of the transformers feeding the circuit is the critical factor. In the adjoining table, check your transformer capacity against the "IC" corresponding to your particular circuit voltage. The interrupting capacity of your protective devices should be equal to or greater than the short-circuit currents available as determined by your transformer capacity.

THESE SHORTS ?



That protective device ahead of the fault should have an "IC" (interrupting capacity) rating of 25,000 amperes. Anything less* can mean danger in the form of a destroyed device, flying metal, or possibly flaming oil. If the protective device on the branch feeder explodes or fuses together because of inadequate "IC," it means a power shutdown in the entire plant with consequent production losses. If your installation is similar to the one shown, refer to the table below and check the "IC" of *your* protective devices.

*Some fused knife switches and oil circuit breakers may have a maximum "IC" of only a few thousand amperes.

POWER SHUTDOWNS

INSTALL G-E AIR CIRCUIT BREAKERS if you need more "IC." It's easy to select the proper G-E air circuit breaker from the table. And you can be sure they have adequate "IC" to safeguard your production, equipment, and personnel. By providing three-phase interruption of dangerous overcurrents, G-E breakers eliminate the possibility of single-phasing damage to motors. Workmen can operate these breakers easily. A turn of the handle and power is restored—no parts to be replaced.

WRITE FOR THESE BULLETINS on G-E air circuit breakers, or contact your G-E sales representative. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GEA-3600 AE-1 Air Circuit Breakers
GEA-3642 AL-2 Air Circuit Breakers
GET-1113 Selection and Application of Breakers
GET-1233 Short Circuit Currents in Industrials
GEA-2596 Low-voltage Metal-enclosed Drawout Equipment
GEA-3592 Load-center Unit Substations

INTERRUPTING RATINGS—G-E AIR CIRCUIT BREAKERS TO USE

Transformer Capacity in Three-phase Kva	220-240 CIRCUIT VOLTAGE				440-480 CIRCUIT VOLTAGE				550-600 CIRCUIT VOLTAGE			
	Main Breaker		Branch-feeder Breaker†		Main Breaker		Branch-feeder Breaker†		Main Breaker		Branch-feeder Breaker†	
	"IC"	Breaker to Use	"IC"	Breaker to Use	"IC"	Breaker to Use	"IC"	Breaker to Use	"IC"	Breaker to Use	"IC"	Breaker to Use
300	50,000	AL-2-50	25,000	AE-1-25	25,000	AE-1-25	15,000	AE-1-15	25,000	AE-1-25	15,000	AE-1-15
500	50,000	AL-2-50	50,000	AL-2-50	50,000	AL-2-50	25,000	AE-1-25	25,000	AE-1-25	15,000	AE-1-15
750	75,000	AL-2-75	50,000	AL-2-50	50,000	AL-2-50	25,000	AE-1-25	50,000	AL-2-50	25,000	AE-1-25
1000	75,000	AL-2-75	75,000	AL-2-75	50,000	AL-2-50	50,000	AL-2-50	50,000	AL-2-50	50,000	AL-2-50
1500	....	....	....	....	75,000	AL-2-75	75,000	AL-2-75	50,000	AL-2-50	50,000	AL-2-50
2000	....	....	....	....	100,000	AL-2-100	100,000	AL-2-100	75,000	AL-2-75	75,000	AL-2-75
2500	....	....	....	....	100,000	AL-2-100	100,000	AL-2-100	100,000	AL-2-100	100,000	AL-2-100
3000	....	....	....	....	....	....	....	....	100,000	AL-2-100	100,000	AL-2-100

Note: This table is based on unlimited power supply and 5 per cent transformer impedance.
†If cascading of feeder breakers is used, it is possible that a smaller breaker may be used for branch-feeder service.

GENERAL ELECTRIC

860-32

New Products and Methods

(Continued from page 9)

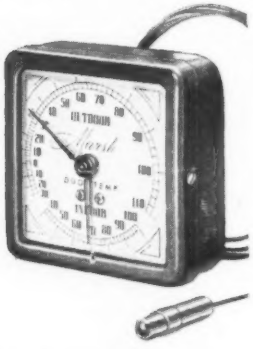
single-pen recording thermometer for recording temperature only, and the two-pen temperature and time-operation recorder, which charts the running time of refrigeration motors in addition to recording temperature. Simplicity of design and construction ensures accuracy in recording. A special transparent, unbreakable plastic front permits full view of entire chart and pen-arm. Pen-arm is "jiggle-proof," and thus temperature record is unaffected by vibration. The instrument is available in models to operate in a wide variety of ranges. Chart drive is a 7-day spring-propelled mechanism with charts of 24 or 72-hr duration. Each recorder is enclosed in an aluminum case with smooth, black enamel finish. Overall dimensions are: 5¾ in. sq. 4¼ in. deep, and total weight is less than 3½ lb.

ITEM NO. 24

Indoor-Outdoor Thermometer

A unique and highly practical thermometer that registers both indoor and outdoor temperatures is now available. This instrument is designed for the private office. It may be placed at any convenient location and is as easy to read as a mantle clock.

The face of the Duo-Temp is divided



into two separate temperature ranges. The top range indicates the outdoor temperatures while the bottom range shows the indoor temperatures. Outdoor temperatures are shown in black and indoor temperatures in red to set off the two temperature scales and to further enhance the attractiveness of the unit. It is announced by Jas. P. Marsh Corp.

ITEM NO. 25

Wood Preservative Paint

A new wood preservative paint, known as Woodtrem, which is reputed to prevent rot and decay has been announced.

According to its manufacturer, Woodtrem penetrates deeply into the pores of wood surfaces and effectively seals out moisture. Its creosote content is poisonous to bacteria. Tests indicate that Woodtrem-treated wood will remain free from rot at least twice as long as surfaces coated with ordinary paint.

Woodtrem is said to be especially adapted for wood that is to be buried in the ground or laid on an earth surface. It is ideal for fence posts, piers, railroad ties, telephone poles, foundation timbers, roof frames, plant boxes, greenhouse benches, shingle roofs, etc.

Woodtrem is available in black and aluminum. The latter is recommended for applications where it is desirable to paint over Woodtrem with another type of paint. Speco, Inc., is the manufacturer.

ITEM NO. 26

Electric Sewer Machine

An electric sewer machine, or rodding tool for removing roots and other obstructions from lateral sewer lines, or rust, scale, slush and sediment from industrial pipe lines, has been recently announced. It can be used for all piping from 3 to 8 in., and is designed so that one man can move and operate the machine. The entire equipment can be carried in the trunk of a passenger car.

The machine is equipped with 110 ft of ¾ in. coil spring cable which is driven at 140 rpm by a ¼ hp, 110 v, 60 c, a-c motor (d-c motor available on request). 50 ft cable extensions can be added. The flexible leader is intended to lead or guide the heavy duty cable around and through short bends and traps in sewer and pipe lines. Spartan Tool Co.

ITEM NO. 27

Concrete Improver

Greatly improved concrete, plaster, and lime-free mortar can now be obtained by the addition of Portite, a safe, easy-to-use liquid that comes ready to add to the mix. As little as ⅛ pint per bag of cement provides more easily workable concrete with less water (reduced in some cases by as much as 35 per cent). Other advantages provided by Portite include reduced shrinkage, with less need for expansion joints, elimination of segregation and dusting. Less time is needed for placing and finishing Portite-improved concrete, and it provides unusually high strength and adhesive qualities.

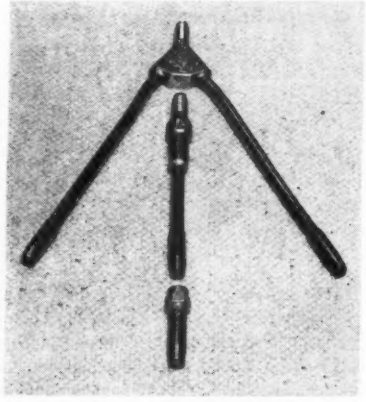
Where required, the concrete can be made absolutely water-tight after an unusually short curing time by the addition of ½ pint of Portite per bag of cement. When used in mortar, it eliminates the need for lime and produces strong, waterproof joints with greatly reduced efflorescence. In cement plaster, finishes, and stucco, Portite provides waterproof, non-dusting surfaces. It is non-contaminating, non-irritating, and non-toxic. Has been under test and in successful use for over five years on various types of construction in a restricted Eastern locality. Offered by Hopper Products, Inc.

ITEM NO. 28

Brazing Tips

The addition of three new multiflame brazing tips to its apparatus line has been announced by the Air Reduction Sales Co.

The tips are recommended for use in silver brazing, high temperature brazing and in the application of hardfacing alloys. It is believed that the three new Style Nos. 721, 722 and 723 will find wide acceptance in industry. They



also have an application in the construction field where aluminum and copper is used.

Style 721 is a light, compact, multiflame tip brazed to the end of a short, completely flexible copper extension. It is available in sizes 5, 6, 8 and 10.

Style 722, which should be especially applicable to the refrigeration field, is a dual tube tip brazed to a flexible copper extension. It comes in sizes 5 and 7.

The Style 723 multiflame brazing tip was developed especially for brazing

Is there a piece of equipment described here that will solve a big problem in your plant? Do you need more information on it in a hurry? Phone or wire prepaid, The Editor, PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago. Tel. Harrison 0824. Your request will be rushed to the manufacturer's nearest branch office or to his headquarters

operations where it is advisable for the operator to be farther away from his work. The tip itself is identical with the tip end of Styles 721 and 722 but should be used with a standard 10 in. flexible extension tube.

All of these tips will operate satisfactorily with various gas combinations —oxyacetylene, oxyhydrogen, oxy-city or natural gas. The latter two types of gases must be under pressure when used for brazing.

ITEM NO. 29

Light Weight Tool Hose

A new light weight hose with rayon strength members and Homo-Flex construction has been designed by Raybestos-Manhattan, Inc., Manhattan Rubber Div. The hose designated Ray-Man is meeting with instant success for bench work with small air operated tools where ordinary air hose is too heavy and cumbersome. It is also said to be ideal in industries requiring air for blowing or cleaning in small areas as in molded products and textile industries because of its ease of handling and flexibility.

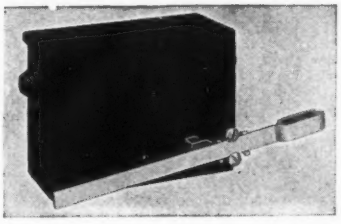
In Ray-Man Hose rayon is used as the Home-Flex strength member, making possible an extremely light hose having great strength and flexibility. This hose is also available in an oil-proof type made with oil resisting rubbers. Both types are made in sizes from ¼ in. to ½ in.

ITEM NO. 30

Float Switch Line

The Standard L-200 Float Switch is described by the manufacturer as a sturdy, two-pole, double-break, snap-back float switch with silver-to-silver contacts. It is a completely packaged float switch, ready to install.

The operating mechanism is housed



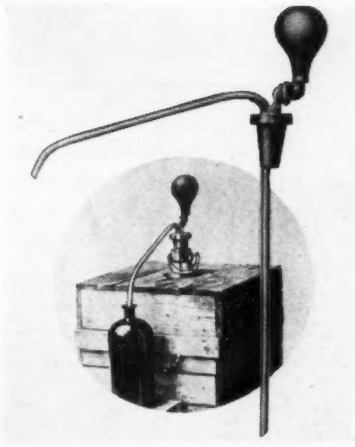
in a 16 gage, drip proof case. By the simple expedient of reversing the lever arm the operation is changed from making contact on rising level and breaking on low to making contact on low level and breaking on high. It is announced by Automatic Control Co.

ITEM NO. 31

Handling Acids Safely

A safe and sane method of acid handling is provided by a manually-operated acid pump supplied by General Scientific Equipment Co. which is finding wide usage wherever liquid must be removed from a carboy, drum or barrel.

Corrosive and other liquids flow smoothly and stop instantly, they come in contact only with the corrosion-



resistant tube and cannot affect other parts. When the pump is removed, acid drains completely. No tilting of the container is necessary and danger of a slip, a splash or a spill is minimized. Damage likely to result when other methods are used can easily exceed the small cost of the pump.

General Scientific Pneumatic Acid Pumps are supplied in hand or foot-operated models. Either can be equipped with a lead tube for sulphuric, hydrochloric, hydrofluoric and similar acids or with a Saran (flexible plastic) tube for nitric, phosphoric, acetic acids, peroxide and many other liquids. Special tube lengths can be supplied at slight additional cost. Hand operated pumps equipped with a lead tube are $9.50 and those equipped with Saran are $11.00. For foot operation add $2.20 to these prices.

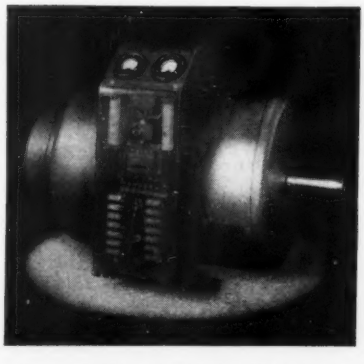
These safe pumps are essential wherever acids are handled in small measure . . . in industry, laboratory, plating-room or battery service station. Nationally known chemical manufacturers as well as many specialty establishments find them an inexpensive must for safety, for neatness, and for economy. Descriptive literature sent on request.

ITEM NO. 32

Packaged Generators

This new "Packaged" generator announced by Electric Machinery Mfg. Co. for use in engine-generator sets is a compact, factory-assembled unit including revolving-field generator, direct-connected exciter, automatic voltage regulating circuit, meters, and selector switch for pre-setting voltage. The only external connections needed are leads to a generator switch.

The built-in automatic voltage regulating circuit has no moving parts and requires no maintenance; it is perma-



nently connected and factory-adjusted to hold terminal voltage within 2 per cent of the voltage selected, at any load or power factor within the generator rating.

Popular 60-cycle ratings at standard voltages and 0.8 pf include: 18.7 kva, 25 kva, 31.3 kva at 1200 rpm, and 25 kva, 31.3 kva, 37.5 kva at 1800 rpm.

The principle of electrical resonance, long used for needle-sharp tuning of radios, is used to hold constant voltage. Operation of the circuit is detailed in Publication No. 186 and is available.

Do you want more information on this equipment and its application? Use the no obligation, no postage card between 18 and 19 and 58-59

New Products and Methods

ITEM NO. 33

Rubber Mat for Easy Standing

A new non-marking, non-skid rubber mat called "Stand-eze Softaire" for the relief of standing fatigue, has been announced.

Available in size 16 in. by 23½ in., this new mat comes in three color combinations chosen to subdue footprints; blue and white, gray and white and solid slate gray. The "Stand-eze" mat is also available in Neoprene oil-and-grease-resistant rubber at slight additional cost.

The mat is designed with nearly 2000 small rubber cells, which act individually and collectively to protect legs and feet from nervous strain. Cells of the "Stand-eze" mat are so constructed that they gather and retain air. Thin rubber strips of the toughest rubber, criss-cross each small cell, producing a "squeegee" action.

Combining the floating action of the air retaining cells, with the "squeegee" action of the thin rubber strips, the Colonial "Stand-eze" mat has a proper resiliency to make standing pleasurable, without any sensation of annoying softness. Anyone, regardless of weight, using the mat is assured of a highly flexible, pillowing action. It is announced by Colonial Rubber Co.

ITEM NO. 34

Portable Incinerator

Plibrico Jointless Firebrick Co has announced the development of a line of portable incinerators for the safe and easy disposal of all kinds of industrial and institutional refuse. The incinerator is well suited for the needs of industrial plants, institutions, hotels, restaurants, stores, tourist courts and other establishments with a moderate amount of wet or dry refuse to dispose of. It eliminates the hazards of burning refuse in the open or the nuisance of hauling it away.

The incinerator is made in three sizes, with grate widths of 24 in., 36 in., and 48 in. The destructive capacities per hour of the three sizes are: Typical garbage (6 per cent wet, 40 per cent dry), 24 in.—65 lb; 36 in.—100 lb; 48 in.—135 lb. Dry paper waste, 24 in.—135 lb; 36 in.—200 lb; 48 in.—280 lb. Dry mixed wood shavings and sawdust, 24 in.—270 lb; 36 in.—400 lb; 48 in.—550 lb. These capacities are based upon the use of a 15-ft stack and no

(Continued on page 66)

Bulletins . . . . Catalogs

Keep posted on current practice, learn what other plant engineers are doing. Know the how and why when the need arises. Mark the bulletins you want by number—or ask questions on specific applications—on the no obligation, no postage, "Mark, Clip and Mail" postcard between pages 18 and 19 and 58 and 59

MAINTENANCE

ITEM NO. 100

Brushes—Maintenance brushes, paint and varnish brushes and wire and fiber wheel brushes are described in this new 76-page, three-color Catalog 200. Designed to simplify selection of brushes for each job, the publication contains many innovations. Among these is a 3-page section devoted to factors involved in the selection of brushes for specific jobs and including operating equipment requirements, brush characteristics, operating conditions, surface speeds and other helpful information. The Osborn Mfg. Co.

ITEM NO. 101

Chart for Rust Prevention—An excellent chart on applications and use of rust preventives, their removal, physical description and miscellaneous data has been prepared by this company. The chart measures approximately 22 by 18 in. and may conveniently be hung on the wall for ready reference. The back of the chart presents information on U. S. Government specifications for the company's materials. Nox-Rust Chemical Corp.

ITEM NO. 102

Maintenance Ladders—Various types of maintenance ladders are described and illustrated in this 20-page bulletin. Complete and detailed descriptions of how to operate the ladders are accompanied by excellent photographs of the ladder being operated and used on typical jobs. Reasons why the ladder is strong and safe are pointed out by means of descriptions and photos. The various types are shown and line drawings illustrate the dimensions and sizes available. Metropolitan Device Corp.

ITEM NO. 103

Protective Coatings—A 12-page catalog giving complete details of application, the chemical properties and physical properties and other pertinent data on protective coatings has been issued. Catalogs are available for 10 major industries, giving full technical information pertaining to each industry. Amercoat Div., American Pipe and Construction Co.

ITEM NO. 104

Metallizing Equipment—Catalog 400, 6 pages, describes the many items in the company's line for use in maintenance and repair by means of metallizing. Shown and described are spray guns, fusebond units, metallizing machine, air control unit and many others. Metallizing Engineering Co., Inc.

ITEM NO. 105

Corrosion-Resisting Equipment—Process equipment made with this company's corrosion resisting alloys are shown and described in a unique manner in this new bulletin. The various types of equipment are listed on one side of the page in a color block and the names of the alloy which should be used, a description of the uses and applications of the equipment follow in the next columns. The booklet provides a quick reference chart. The Duriron Co., Inc.

ITEM NO. 106

Flooring Composition Bulletin—Here is a 4-page bulletin which describes the advantages obtained from the installation of the company's flooring composition. As the bulletin points out, this material must be installed by a contractor trained in the business and the bulletin merely points out the features of the material; some of these features are resilience and flexibility, lack of shrinkage, resistance to oils, fats and greases, fire proof, sanitary and vermin proof, etc. The bulletin further points out that the composition can be applied in one or two coats over wood and that it sets rapidly. It is available in several colors. Photographs of installations and listings of places where the material has been used are given. Selby, Battersby & Co.

ITEM NO. 107

Repairs Handbook—Here is a 40-page handbook crammed with information on all types of repair procedures for every conceivable piece of equipment and location. Made doubly useful through the skillful use of line drawings the booklet covers the following subjects, to name a few: anchoring bolts and screws, auto engine repairs, auto radiator leaks, oil-proofing concrete, cracked pipes, leaks in heater joints, water jacket cracks, welding, manifold connections, fire pot cracks, roof leaks, and many, many others. Smooth-On Mfg. Co.

ITEM NO. 108

Chemical Cleaning—Chemical cleaning of heat transfer equipment or for removing mill scale, rust, corrosion and other deposits on metal is described in this new bulletin. Brief directions on the use of the chemical are presented in a step-by-step manner. General pickling operations are described in a separate box on page 3 and similar treatment is given to directions for cleaning heat transfer equipment and for stripping zinc plate. The last page of the folder tells the types of equipment that can be cleaned by this chemical and another listing gives the specifications of the material. Pennsylvania Salt Mfg. Co.

ITEM NO. 109

Concrete and Wood Floor Surfacer—This six-fold folder tells about the company's product for use in patching and resurfacing concrete and wooden floors. Typical examples of the product's use are outlined and a listing of its uses is presented. Detailed directions for application are given. A series of important questions are asked and answered. Stonhard Co.

ITEM NO. 110

Protective Coatings—Bulletin OK-2019, 4 pages, describes an improved protective coating for insulated copper conductors. This coating is designed to outlast tinning and comparisons of the two are given in the text. Excellent illustrations also are given, showing the method of application of the coating and picturing laboratory experiments. The Okonite Co.

ITEM NO. 111

Plastic Tile—This is a 4-page bulletin. It describes a new type of plastic floor tile which is recommended for installation in municipal buildings, hospitals, hotels, department stores, offices, chemical plants, laboratories. The bulletin points out the various features of the tile, such as its water and chemical resistance, its resilience and ease of installation. Specifications of the plastic tile are given in brief form on the back page of the bulletin and 15 color samples show the various colors in which the tile is available. The U. S. Stoneware Co.

ITEM NO. 112

Protective Coatings—This new bulletin on protective coating and lining for steel and other metals describes and illustrates a wide range of the coating's applications, the plant and field facilities of the company, and also describes the research program. Report of actual laboratory tests also are included. Among these are shown the results of suspending coated strips of mild steel at room temperature in various solutions such as inorganic and organic acids and compounds. Photographs show the material being applied to brewery tanks and other surfaces which are subjected to corrosive action. Among the uses of the material as described in the booklet are for application to pipe lines, pipe fittings, flow boxes, fans, blowers, and a variety of parts. Lithgow Corp.

ITEM NO. 113

Faster Floor Repairs—This bulletin points out how important is the time element in making repairs to rough floors. From the standpoint of safety as well as production it shows how it is profitable to use materials and methods that do not tie up traffic lanes or important working areas. A clear description of how to make such repairs is given in the folder which illustrates methods of application. Stonhard Co.

ITEM NO. 114

Waterproofing Service—Three products are described in this 16-page bulletin—one product stops leaks in walls and masonry, the second fills and seals the surface of the masonry and the third applies a finish coat. The bulletin presents an excellent series of photographs showing each of the products being applied to a concrete block wall. Make-up of the various compounds is described in the bulletin and examples of its use are quoted in case histories. Detailed descriptions of methods of appiying the products to walls and even to deepening and widening cracks, crevices and holes is explained. Standard Dry Wall Products, Inc.

ITEM NO. 115

Maintenance, Safety Equipment—There are 60 pages in this catalog No. 26 describing production equipment, commutator maintenance, motor maintenance, electrical maintenance, safety equipment and mechanical maintenance equipment. The booklet is exceptionally well illustrated and tabular material covers specifications and prices. Brief descriptions of the items are included. The Martindale Electric Co.

MATERIALS HANDLING

ITEM NO. 116

Conveyor Units—Booklet No. 2175, 48 pages, is replete with engineering data, and valuable charts, tables and formulas to determine the conveyor unit size and proper operating speed for a given handling capacity and weight of material to be handled. Typical installations are shown and various conveyors are broken down to show component parts. There are many schematic layouts and typical path charts. Also included is a listing of the information needed for estimates. Link-Belt Co.

ITEM NO. 117

Plant Trucks—Fork lift trucks, straddle trucks and carrying cranes are covered in bulletins issued by this company. The various units in the line are pictured and brief descriptive material tells of their capacity and operation. Each is pictured. Tables of dimension, load capacities and weights are given. Hyster Co.

ITEM NO. 118

Overhead Trolley—Folder 2241 describes this company's trolley for overhead conveyors. Features and elements of design are covered and illustrations accompanied by tables of dimensions show the various sizes available. "Selection of the Proper Trolley" and "Relation of Trolley Loads, Chain Pull and Radius of Vertical Curves" provide engineering information on the device. Link-Belt Co.

ITEM NO. 119

Materials Handling—Catalog 23, this company's new materials handling publication, 86 pages printed in three colors, has just been announced. Divided into five classifications for both the hand-operated and the power-operated equipment, the catalog covers the entire line

Is it an emergency? Do you need one of these bulletins in a hurry? Unavoidable delays often hold up delivery of bulletins when handled in the usual manner. In an emergency, phone or wire prepaid, The Editor, PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago. Tel. Harrison 0824. We will contact the manufacturer's representative nearest you or will forward the request, immediately, to the manufacturer's home office

of equipment from power fork trucks to skid platforms and storage racks. The catalog contains excellent illustrations of equipment and installations. Lewis-Shepard Products, Inc.

ITEM NO. 120

Hydraulic Equipment—Catalog No. P-46, 24 pages, describes this company's Porto-Power hydraulic equipment. The catalog begins by telling what Porto-Power is and what its basic elements are; and continues by discussing and picturing its benefits; how it serves the entire shop; the new assortments, improvements and attachments. Every type of equipment and attachment is described and pictured. A series of photographs show typical examples of service on motor vehicles and general industry and construction. A general listing of Porto-Power uses concludes the catalog. Blackhawk Mfg. Co.

ITEM NO. 121

Handling Methods—Form No. RW1-246, 8 pages, shows typical installations of Rapid-wheel gravity conveyors, Rapid Power boosters, Stevedore, Jr., and the Floor-veyor and Press-veyor. Operation data and specifications show the time and labor saving qualities of this equipment. The Warehouser floor truck and Wheel-ezy hand truck are also described. The Rapids-Standard Co., Inc.

ITEM NO. 122

Electric Chain Hoists—This recently published 8-page Bulletin H-100-A completely describes this company's line of electric chain hoists. The bulletin analyzes the need for hoists, shows how in 12 minutes per day operation of the hoist will pay for itself, describes the operation and gives complete specifications, speeds, prices, etc., for one-quarter, one-half and one-ton hoists. Whiting Corp.

ITEM NO. 123

Engineering Manual—This 92-page Engineering Manual and Catalog No. 114 covers the engineering, application, installation and use of the company's line of speed reducers. Inspection and Tests, Selection of Speed Reducers, Design and Construction, Lubrication and Oil Retention are some of the sections in the booklet. Many full page tables of horsepower and torque output ratings and overhung load capacities are included. The book is well illustrated with photos, sketches and blueprint-type drawings. The booklet is plastic-bound in a heavy cover. Winfield H. Smith, Inc.

ITEM NO. 124

Motoreducers Handbook—There are 64 pages in Bulletin 3100, printed in three colors, and they cover a huge amount of engineering and catalog information on this company's standard drives for all requirements. Sectional blueprint drawings of the units, and complete descriptions comprise the fore part of the bulletin. "Method of Selection," and "How to Select," precede many tables of selection data on three classes of drives. Falk Corp.

ITEM NO. 125

Catalog on Gears—Double helical gears are described in Bulletin 1958-A; the Bulletin points out how it is often advantageous to use gears in order to secure the highest economy of operation of both turbine and driven machines. Specifications of the company's gearing is described and in this section is covered the gear case, bearings, lubrication. Applications of the unit for reducing and increasing speed also are covered. Several pages of photographs of geared turbo units installed in various plants are given. The back portion of the catalog covers outline dimensions—tables of dimensions accompanied by drawings. Moore Steam Turbine Div., Worthington Pump and Machinery Corp.

ITEM NO. 126

V-Belt Booklet—This new bulletin, 26 pages, describes features and advantages of the company's line of link V-belt which is adjustable to any length and adaptable to any drive. Construction details of the belt are thoroughly explained and a series of "how-to-do-it" photos show how to couple and uncouple, measure and install the belt. Also included are tables of engineering data and 13 pages of application photos showing installations in a wide variety of industries. Manheim Manufacturing & Belting Co.

ITEM NO. 127

Roller Chain Drives—"The Diamond Diesel Drive Dozen," is the title of a new bulletin which covers roller chain engine drives. Included in the booklet are a series of examples of timing, pump, generator, blower, exciter and other auxiliary drives. Installation views and schematic drawings illustrate clearly these engine applications. Diamond Chain Co., Inc.

INSTRUMENTS, CONTROLS

ITEM NO. 128

Orifice Flow Meter—This new 12-page Bulletin 35-83A on the company's flow meter of the orifice type has just been issued. The meter, for indicating, recording and integrating the flow of steam, gas and air, is described in detail and data on orifice plates, etc., are given. American District Steam Co.

ITEM NO. 129

Controls Handbook—Catalog 600A is a 64-page combination handbook and catalog of automatic controls for industrial applications, heating, air conditioning and refrigeration. Wiring diagrams occupy a considerable portion of the booklet; each of these illustrate various hookups using the company's controls. Complete catalog information on all the controls in the line accompany illustrations of each item. Descriptions of alternating current relays, pressure limit controls, differential pressure controls, vapor vacuum limit controls, and many others are included. Stoker controls, industrial oil burner controls, automatic gas pilot controls, and many controls of this general type are described in the back part of the booklet. Other engineering data presented in this section includes conversion tables, ordering data for special controls, and two full pages of control dimensions accompanied by line drawings. The Mercoid Corp.

ITEM NO. 130

Metering—Bulletins 349 and 350A have been issued by this company describing its "Shuntflo" meter and its "Propelloflo" meter. The former is an 8-page bulletin which tells about the company's meter for steam, air or gas metering. Table of capacity is given and excellent drawings and photographs show construction and operation of the unit. Installation is pictured in 3 blue print-type drawings. A full page table of capacities is presented. Bulletin 350A is a 4-page bulletin describing the meter for direct reading on main line metering. Features of construction and operation are listed and drawings and charts complete the bulletin. Builders-Providence, Inc.

Mark the numbers of the bulletins you wish to receive on the no obligation, no postage card between 18 and 19 and 58-59

ITEM NO. 131

Armored Flowrators—Catalog Section 40-B is an 8-page bulletin which tells about the company's flowrators for high-pressure fluid flow rate measurement and control. Completely illustrated, the catalog points out the various construction features of the Flowrators and also gives dimension tables for the units. A Flowrator capacity guide is given on the last page of the folder. Fischer & Porter Co.

ITEM NO. 132

Thermal Units—This 4-page pamphlet describes this company's thermal conductivity units which are stated to be sensitive, rugged, compact, accurate and dependable. The bulletin points out what it does, where it is used, why it is dependable, its advantages, specifications, accessories and prices. A wash drawing of the unit, with the help of arrows, points out its most important features and a line drawing shows a typical electrical circuit for gas measurement. Other instruments manufactured by this company are pictured and described on the back cover. Gow-Mac Instrument Co.

ITEM NO. 133

Critical Temperature Monitor—This monitoring system which warns of approaching critical temperatures of bearings anywhere in the plant is described and pictured completely in this new 12-page bulletin. A series of diagrams shows how the system may be used in the plant and tells of the several possible methods of reading and taking action upon warning. An explanation of how the system works is given and details of construction and parts are presented. The bulletin also has wiring diagrams and supplementary information. Thomas A. Edison, Inc.

ITEM NO. 134

Water Temperature Control—The 16 pages in Condensed Catalog 3035 are crammed with information on the company's temperature regulators for water heaters of various types, fuel oil heaters and others; on automatic water mixing valves, and accessories. A typical page in the booklet contains drawings of hook-ups, tables of specifications, tables of capacities, table of list prices and shipping weights, a brief description of the product, its features and advantages and application. Sectional views of the described products are shown and an exterior photograph is given. Drawings of roughing-in dimensions of some of the products are given. The bulletin is exceptionally well illustrated and arranged. The Powers Regulator Co.

ITEM NO. 135

Electronic Combustion Control—Bulletin SA-2-47 describes this company's Bobot-Eye, the electronic combustion control which has been designed for industrial plants, hotels, office buildings and large apartments. Advantages of the unit, what it does and how it does it are described in the front part of the bulletin. Its application to rotary cup burners is described in detail. The complete equipment is described and the component parts which made up the system also are described and illustrated. Methods of installation are shown by means of line diagrams and charts show linkage movement and oil consumption. Typical applications of the control to heating boilers are presented on the last page. General Power Plant Corp.

ITEM NO. 136

Magnetic Crane Controls—Five types of magnetic crane controls for handling any type of load are described in this 20-page booklet B-3853. It contains descriptive information, wiring diagrams, performance curves and application guide to aid in selecting the type of a-c control best suited to any application. Special attention is given to the reactor system, a new development particularly applicable where spotting of the load is important. Installation photographs are included. Westinghouse Electric Corp.

ITEM NO. 137

Radiant Heating Control Handbook—The 40 pages in this excellent book cover the theory and application of automatic control of radiant panel heating. The subject matter includes such material as Comparison of Panel and Convection Heating, The Function of a Heating System, Control Requirements of the Two Systems, Rational Solution of the Control Point Problem, etc. Charts, and piping and control diagrams are used to illustrate the booklet. Minneapolis-Honeywell Regulator Co.

ITEM NO. 138

Electronic Controls—This 20-page booklet, Bulletin Z-6400, is a condensed catalog containing information, listings and specifications on the company's standard instruments. Proportioning, automatic positioning and program control are explained with graphs, diagrams and photographs. Various types of controllers, indicating pyrometers and resistance thermometers, input controllers and many other controls are covered. Wheelco Instruments Co.

ITEM NO. 139

Thermal Procedure Handbook—This bulletin on Thermoswitch Controls, 58 pages, has been compiled for the use of engineers concerned with temperature in all industries. The bulletin is extremely well arranged and is printed in several colors for ease in understanding many of the drawings and charts presented. Complete engineering information on the various types of controls is given and installation and operation are covered. Methods of checking the system under operating conditions are described and the special features of the unit are covered. An application questionnaire and price list complete the booklet. Fenwal Inc.

ITEM NO. 140

Industrial Instrumentation—Catalog 370 is a 16-page bulletin covering the company's line of indicating, recording and controlling instruments for temperature, pressure, flow, liquid level, humidity and other process variables. Types of control mechanisms are described in the fore part of the bulletin and the remainder of the bulletin presents detailed engineering and construction and operational information

on controls and parts. The catalog is well illustrated with photos and sketches and tabular material supplements some of the descriptive matter. The Foxboro Co.

ELECTRICAL

ITEM NO. 141

Fuse Booklet—An excellently done 16-page pocket-sized booklet on the outstanding features of construction of this fuse (such as the renewable link and spring tension locking of links in circuit) was issued recently. Easily-understandable full-page wash drawings are used to emphasize every feature discussed. Two pages of prices and specifications on the fuses are given in the back of the book. Ware Brothers.

ITEM NO. 142

Renewable Fuses—"The Inside Story of Trico Renewable Fuses" is a 24-page booklet extensively illustrated with drawings and charts which show in detail the features of the fuses. It is quick-reading and gives helpful information for increasing production by eliminating unnecessary shut-downs. Greater safety against fire and accident hazards are also stressed by the bulletin. Trico Fuse Mfg. Co.

ITEM NO. 143

Wiring Devices—Hundreds of wiring devices are described in this excellent 76-page Catalog 42. Among the items covered are wall plates, switches, convenience outlets, circuit breakers, fluorescent equipment, lamp receptacles, sockets and many more. The bulletin is well indexed and sheets of prices and discounts are included. Pass & Seymour, Inc.

ITEM NO. 144

Connectors—"Connectors for Grounding" is the title of a new Catalog G47 just published. The 32-page catalog presents the company's broad line of grounding devices. In addition, the publication provides a comprehensive discussion of modern grounding practice. Burndy Engineering Co.

ITEM NO. 145

Vest-Pocket Tester — This bulletin describes fully this vest-pocket tester for continuity and line testing. Many examples of the testing work which can be accomplished with the device are shown by means of line drawings and brief descriptions of the test procedure. Other products such as test pocket pliers and fuses are covered. Star Fuse Co., Inc.

ITEM NO. 146

Instrument Panels — Instrument panels and cubicles are covered in considerable detail in this new bulletin. Drawings which show the various types in the line are followed by actual photos of installations. Dimensioned drawings and brief descriptions of some of the units are presented and one full page is used to give ordering information. Falstrom Co.

ITEM NO. 147

Condensed Catalog — This 76-page condensed catalog, just issued, serves as a valuable source of reference and information on this company's products. It includes size, capacity and dimensional data together with current prices. The catalog covers industrial safety switches, service equipment, multi-breakers, industrial circuit breakers, duct, and lighting and power panel boards. Square D Co.

ITEM NO. 148

Electric Rail for Tools—This 4-page folder describes the company's electric distribution system which is designed to provide power for all types of movable electrical equipment such as tools on a production line or for portable bench tools and for test work. The bulletin presents phantom views of different types of "Feedrails" and shows them as installed in various types of industries. Feedrail Corp.

Mark the numbers of the bulletins you wish to receive on the no obligation, no postage card between 18 and 19 and 58-59

ITEM NO. 149

Hi-Frequency Conductor—Water cooled, flexible leads for use in conducting high frequency currents are described in a folder just issued. Included is a description of tests which demonstrate the low power loss resulting from the use of the lead. Tables, diagrams and list prices are included. Titeflex, Inc.

ITEM NO. 150

Electrical Service Equipment — Bulletin 501 describes many items in this company's line of electrical devices. Included in the catalog are magnetic circuit breaker service equipment, local centers, meter connection boxes, range switches, safety switches, panel boxes and padlock seals. Each of the items is well described and most are accompanied by photos and tables of sizes or capacities. There are 26 pages in a separate cover. Metropolitan Device Corp.

ITEM NO. 151

Axial Air-Gap Motor—Bulletin 2760 is a 16-page bulletin which describes the many applications of the company's recently-announced axial air-gap motor. Following a detailed description of the motor, a series of photos showing representative applications of the unit are given. Tables and drawings of dimension data for horizontal, vertical and pivot base mounting and space and weight data are presented. Fairbanks, Morse & Co.

ITEM NO. 152

Built-In Motors—There are 16 pages in this new Bulletin 516-D. The booklet is concerned with the company's Type CT, rolled shell, shaftless squirrel cage induction motors for built-in drives. Exceedingly well illustrated with both line drawings and photos, the bulletin covers every detail of the motors' construction, features and operation. Tables of horsepower ratings and photos of actual applications of the motors to woodworking and metal working machinery are presented. Louis Allis Co.

ITEM NO. 153

1947 Reference Book, Buyers' Guide—This 100-page reference book, buyers' guide and condensed catalog has just been issued; it covers the company's complete line of control devices, radio and electronic supplies. This exceedingly complete booklet includes everything from intercom systems to friction tape, from electronic tubes to electric drills. All items are priced and complete tables of specifications are included. Illustrations are included for nearly all items in the booklet. Walker-Jimieson, Inc.

ITEM NO. 154

A-C Generators—Vol. 8, No. 3a is a 16-page bulletin containing valuable information on a new "packaged" a-c generator. Included are tables showing how to select types of low-voltage electric service for the generator sets; the approximate power requirements for induction motors; and how to figure wire sizes. The various components in a control cabinet are diagramed. Typical installations are photographed. Included are diagrammatic indeces of generator switchgear for single, non-parallel, low-voltage generator, for paralleled, low-voltage generators and for paralleled high-voltage generators. There is also a discussion about how the oil and gas fields use generators. Electric Machinery Mfg. Co.

ITEM NO. 155

Control Device—This new 36-page booklet, B-3649, on automatic operation for electrical equipment, describes the company's Rototrol, tells what it is, what it does and how it works. It tells how the Rototrol regulates voltage, speed, current, power, torque, power factor, position, and how it provides stability control and current limiting. Illustrations consist of photographs, schematic diagrams and performance curves which describe the Rototrol applications in the metal-working, mining, paper, rubber and other industries. Seven pages of technical information are included giving additional data on the theory, design and operating principles and several frequently used modifications. Westinghouse Electric Corp.

ITEM NO. 156

Electrical Precipitation—There are 28 pages in this booklet on the Cottrell Process of electrical precipitation. The booklet outlines the three gas cleaning problems which industry must face and from there goes on to show how the Cottrell electric precipitator works. Exceptionally fine drawings illustrate the process and detailed descriptions of construction of the unit are included. The larger part of the bulletin consists of photographs of actual installations in power plants, smelters, acid plants, pulp and paper mills, etc. Research Corp.

ITEM NO. 157

Speed Drives—This is an excellent 24-page bulletin describing a line of speed drives. Diagrams and subject matter show how the drives work. Typical installations are photographed. There are two pages of photographs showing the various features. An enlarged photo details how a motor is placed upon a machine. Other photographs present information on a number of manual and electric remote control drives. Also described is the manner in which the drives are inspected. Master Electric Co.

ITEM NO. 158

Distribution Transformers Manual—Bulletin TU-180, consists of 62 pages of catalog information and technical data on the company's line of distribution transformers. Included in this material is a consolidated price list and complete descriptive data on transformers for 1½ to 500 kva up to 73,000 volts. Catalog information consists of detailed descriptions and listings of parts of units while the engineering information gives installation and operating instructions. Considerable general information on transformers is given in still more engineering data sheets. Wagner Electric Corp.

ITEM NO. 159

Splices and Tapes—This booklet, OK-1007A, describes, in picture and text, proved methods and materials that result in perfect splices. Sections such as "What You Should Expect of Rubber Splicing Tape," and "What You Should Expect of Friction Tape," tell the story of products and then the latter section of the booklet "General Instructions for Joining Rubber Insulated Cables Up to 5000 v," shows in step-by-step photos and accompanying description the methods of joining. The Okonite Co.

ITEM NO. 160

Diesel Engines, Generating Sets—This bulletin describes power units of 3¾ to 56 h.p. generating sets from 2,000 to 36,000 watts and marine propulsion engines 3¾ to 62 h.p. Operating principle and a description of the simplicity and economy of operation of the units are covered in the first several pages of the bulletin. Typical installations of the units on river boats, in machine shops, fruit farms, foundries and hatcheries are presented. R. H. Sheppard Co.

STEAM GENERATORS

ITEM NO. 161

Packaged Steam—Described in this 8-page bulletin is a functionally-designed steam generating unit. The steam generator is reported to be fully automatic when burning all commercial standard grades of oil. Outstanding features of the boiler are listed and described in some detail. A double-page cutaway illustration of the unit printed in four colors shows path of gas travel and the interior construction of the unit. Specifications for the boiler equipment; for burner equipment when using No. 5 and No. 6 oil; burner equipment for light oil; extra equipment and gas-fired units is given on the inside back cover. Tabular material covers dimensions of all principal parts of the unit for the 17 different size generators in the line. Superior Combustion Industries, Inc.

ITEM NO. 162

Steam Generators—This new 4-page bulletin points out the advantages of this company's line of steam generators. Among the many features to which the bulletin calls attention are: the combustion method, simple two-pass construction, completely automatic operation, automatic wide-range modulation and operating efficiency. A table of ratings and dimensions is given and several illustrations are published. Cyclotherm Corp.

Is it an emergency? Do you need one of these bulletins in a hurry? Unavoidable delays often hold up delivery of bulletins when handled in the usual manner. In an emergency, phone or wire prepaid, The Editor, PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago. Tel. Harrison 0824. We will contact the manufacturer's representative nearest you or will forward the request, immediately, to the manufacturer's home office

TREATMENTS

ITEM NO. 163

Water De-Ionizing—The economical advantages of de-ionized water for uses previously reserved for distilled water, and the equipment necessary for de-ionizing the water, are explained in detail in two bulletins issued recently by this company. Principles of de-ionization are described in detail and a three color chart points out the highlights of the explanation. Advantages of de-ionization also are covered in considerable detail. Photos of the equipment and of actual installations are given. Illinois Water Treatment Co.

ITEM NO. 164

Hot Process Water Softening—A description of the complete hot lime and soda process water softener of this company's system is described in this bulletin. First is presented a list of units (in the sequence of their location in the cycle of operations) and the functions of these units are described briefly. Positive control of chemical feed described as "the heart of the process," receives detailed treatment. A 2-page illustration presents an excellent drawing of the general assembly of the company's water softening plant. All major plants in the system are numbered and an accompanying list names these parts. Sectional views and detailed descriptions of various parts of the system follow. Typical installations are pictured. The American Water Softener Co.

ITEM NO. 165

Chemical Feeding for Water Treatment—Bulletin 101-B, "Corrective Chemical Feeding," is a 12-page folder which describes the company's equipment for proportioning chemical feeding to raw water. The method followed in this proportioning is described in detail and methods of determining and controlling dosages are given. Illustrations show not only the equipment but typical assemblies of various pieces of equipment with connections. A guide to the selection of the company's chemical feeders and lists of typical specifications is given. The American Water Softener Co.

ITEM NO. 166

Soot Remover, Fuel Oil Treatment—Two bulletins, issued recently, cover fuel oil treatment and procedure and soot removal. An explanation of what takes place when sludge forms is presented and the difference between treated and untreated tanks is explained by description and drawings. Method of use of the compound is given. The bulletin on soot removal shows the difference in boiler tubes when treated and untreated and gives information on loss of efficiency due to soot formation. Alladin Laboratories, Inc.

ITEM NO. 167

Water Softeners—This new Bulletin 5 describes this company's latest type sodium and hydrogen zeolite water softeners and demineralizers. The bulletin concisely outlines the applications, principles of operation, and the equipment used in these methods of water treatment. It is illustrated by flow diagrams and drawings showing the design of the company's equipment. Liquid Conditioning Corp.

ITEM NO. 168

Packings Catalog—As a convenient guide to its line of mechanical packings, this company has just issued a 20-page condensed catalog, PC-100. The catalog, printed in two colors, contains information on service applications as well as construction and performance features of the most widely used packings in the line. The catalog also contains the well-known "ABC Chart for Palmetto Self-Lubricating Packings." In addition to many other features the catalog presents 42 interesting illustrations. Greene, Tweed & Co.

ITEM NO. 169

Packings Catalog—Describing and illustrating the complete line of the company's packings is the purpose of this recently-issued 16-page condensed catalog. Many tables of weights are included in the booklet and service recommendations are given for each type of packing. An exceptionally useful section of the booklet is a recommendation chart showing the style numbers of packings recommended for practically every type of service. Asbestos Packing & Textile Div., Raybestos-Manhattan, Inc.

ITEM NO. 170

Packing—Three catalog sheets describing stainless steel packing, air cushioned packing and packing for oil refinery service have just been issued. Each of the folders pictures the packing and besides giving a brief description of its construction it lists the various uses for which it is recommended and gives tables of sizes and weights. The Allpax Co.

PIPE FITTINGS

ITEM NO. 171

Acid-Proof Fixtures, Fittings—This company's line of acid-proof sinks, sink strainers, traps, floor drains, pipe and fittings are described in Bulletin 703. The bulletin introduces the subject of acid resistant material by showing, schematically, a test setup in which their material was subjected to a 10 per cent nitric acid solution along with other metallic substances as lead, cast iron, steel and wrought iron. The period of resistance for which the various metals endured the corrosive action of the nitric acid solution are listed. Excellent photographs and line drawings of industrial installations of the material are shown and the accompanying description tells where best this material will fit. Instructions for installing are given and a check list of corrosive waste disposal systems in various types of buildings is given. The Duriron Co., Inc.

ITEM NO. 172

Self-Cleaning Strainers—Bulletin A-12 is a 4-page bulletin which describes this company's recently announced self-cleaning strainer. Construction of the strainer is completely described and the accompanying illustrations also show construction and, further, serve to supplement the section on "How It Operates." A table of dimensions is accompanied by dimensioned drawings. Elliott Co.

ITEM NO. 173

Prefabricated Pipe Units—Designed so that it will be of greatest practical use to engineers is a new bulletin, Form 4626, which gives specifications for underground pipe distribution systems employing prefabricated insulated pipe conduit. It is a comprehensive compilation of data arranged in convenient tabular form with supplementary diagrams and charts. The RicWil Co.

ITEM NO. 174

Welded Fittings Data Book—Bulletin WT-46, an 18-page engineering data book on the company's forged fittings presents a wealth of information on the installation of fittings, their selection and the design of systems. Uses of the three types of outlets are explained in picture and text. Application and structural data tells where and why the fittings are used and shows typical installations. Under the head "Just Four Easy Steps," the bulletin shows the layout, the hole-cutting, tack-welding and welding-in-place details of installation. Handy tips and clearly worded directions make these four steps easy. Tables of temperatures and pressures and tables of stock sizes, dimensions and prices are given as are dimensioned tables and drawings. Bonney Forge & Tool Works.

ITEM NO. 175

Steam Traps, Filters—Two 4-page bulletins have just been issued by this company; one of them describes its steam traps and the second one its "Kleen Air" filter. The first of these shows a sectional view of the steam trap and completely describes its action. A table of data including prices is included. Exterior views of other traps in the line are also presented. The bulletin on the filter illustrates the principle of operation, gives a table of specifications and describes the construction of the unit. Kaye & MacDonald, Inc.

PUMPS, COMPRESSORS

ITEM NO. 176

"On-The-Spot" Air—This new bulletin tells about the advantages of "On-The-Spot" air which is made possible by the use of small compressors strategically spotted about the plant near points of use. The bulletin presents charts showing pressure drops through long runs of piping and pressure-volume relationship. A plant survey is outlined on the last page. Kellogg Div., American Brake Shoe Co.

ITEM NO. 177

Liquid Pumps—This 4-page booklet has been issued by this company to describe its twin-line liquid pumps. A cross-sectional drawing of the pump is used as a vehicle to describe the outstanding construction features of the unit. Dimensioned line drawings show sizes of the units. The Cooper-Bessemer Corp.

ITEM NO. 178

Centrifugal Pumps—Three bulletins, 713-1, 715-1 and 718-1, describing the company's types of centrifugal pumps were issued recently. They are respectively, 2, 12 and 2 pages in size. All three are well illustrated, contain complete specifications, charts of performance and drawings and tables of dimensions. In addition, the 12-page bulletin describes materials of construction and gives information on details of construction. Goulds Pumps, Inc.

ITEM NO. 179

Air Compressors—Bulletin E-219, describes a new line of industrial air compressors. It contains mechanical data and specifications on complete units from 60 to 315 cfm capacities. It also lists bare compressors suitable for installation with customers' motors or as replacement machines. Advantages of the "departmental" or "at-the-job" compressor system are described in the catalog. Davey Compressor Co.

ITEM NO. 180

Centrifugal Pumps—Bulletin 4013-A describes this company's single stage, side suction, centrifugal pumps. A sectional view of the unit and exterior views are used as illustrative material and various parts of the unit also are shown in half-tone illustrations. Types of construction and tables of performance for motor driven and belt driven units are given. One full page of dimensional tables also shows dimension drawings. Another product described is sump pumps. Engineering information includes tables of comparison of pressures and other conversion factors, suction lift of pumps, suction head requirements when pumping hot water and tables of pipe friction. The Deming Co.

ITEM NO. 181

Rotary and Power Pumps—These two bulletins—W-487-B10B and W-412-B30A—describe this company's heavy duty rotary pumps and horizontal duplex plunger pumps, respectively. Both the bulletins have six pages and present cutaway views of the units. Tables of performance and specifications and sizes and ratings data are given. The first of these bulletins also gives a chart of performance. Worthington Pump & Machinery Corp.

ITEM NO. 182

Pumps Data Book—The 180 pages in this paper-bound Catalog No. G-47 are filled with complete information on all the pumps and water systems in the company's line. Among the types covered are centrifugal pumps, sump, deep well, rotary, oscillating, etc. Besides complete descriptions of the units there are full page tables of performance data. Cut-away illustra-

Mark the numbers of the bulletins you wish to receive on the no obligation, no postage card between 18 and 19 and 58-59

tions show construction and operation of the units. Engineering information, telegraph ciphers and indexes are given in the last 15 pages of the book. The Deming Co.

ITEM NO. 183

Deep-Well Pumps—Submersible deep-well motor-pump units are described in Bulletin 46-5000. There are 12 pages in the catalog. The bulletin points out how the pumps (capacities of 7,000 to 20,000 gpm, heads to 1,500 feet) are in actuality a packaged pumping station. Sectional views through the pump and casing illustrate operation and construction of the units; tables of capacities and sizes are presented. Photos of actual installations are given. Byron-Jackson Co.

ITEM NO. 184

"The Hydropress Pump"—Here is a 12-page Bulletin 46-6000 which describes a pump designed for those who have high pressure, low volume pumping jobs requiring maximum efficiency. In three colors throughout the 12 pages, this bulletin covers technical data, application pictures, cross-section drawings of parts, operation and design features, dimensional sketches and assembly procedure. One of the installations featured and pictured in the unusual pump application at the rim of the Grand Canyon where four of these pumps lift water 3,200 feet. Byron Jackson Co.

ITEM NO. 185

Centrifugal Pumps—There are 8 pages on the company's line of centrifugal pumps from ½ to 2 in. side suction in Bulletin 3900-B. Performance tables for the various models are presented and excellent photographs picture overall and details of construction. Specifications are included. The Deming Co.

ITEM NO. 186

Air Compressors—Bulletin H-620-B26 is a four-page bulletin covering the company's "Air King" compressors. Two tables of capacities and ratings, one for the single stage unit for pressures of 100 to 150 psi and one for the two-stage unit for pressures of 125 to 250 psi, are presented. Specifications and standard equipment are given in list form and another table of weights and dimensions is printed on the last page of the bulletin. Worthington Pump & Machinery Corp.

ITEM NO. 187

Centrifugal Pumps Bulletins—Bulletins 227 and 236 (both revised) describe three types of single stage, double suction centrifugal pumps. Detailed specifications of the units are given and full-page tables of capacities in gallons per minute at various heads round out the information. Dimensions of the units are shown by means of a full page table which is accompanied by dimensioned drawings. Warren Steam Pump Co., Inc.

HEATING, VENTILATION

ITEM NO. 188

Air Diffusers—A new catalog and engineering data book on this company's adjustable ceiling air diffusers has just been issued. Containing all the information necessary for the proper selection of air diffusers in one concise manual it is expected that this book will be of considerable value to plant engineers and contractors. Besides catalog data much information of a general nature on the subject of air diffusion is included. There are 32 pages bound in a heavy paper cover. W. B. Connor Engrg. Corp.

ITEM NO. 189

Radiator Traps—This catalog sheet is packed with information on two types of radiator traps in the company's line. Both are illustrated, described and features of each are given. Tables of prices and sizes are included. W. H. Nicholson & Co.

ITEM NO. 190

Steam Heating Systems—Form 651 is a new bulletin which completely covers the advantages and equipment involved in the company's system of steam heating. Engineering information includes "How to Select Correct Size," "Architectural Specifications," "Design and Installation Data," and several more sections. The booklet is extremely well illustrated, contains 20 pages and is printed in two colors. Warren Webster & Co.

ITEM NO. 191

Traps, Steam Control—Bulletin 201 and Bulletin 901 describe, respectively, float and thermostatic traps, and steam heating and temperature control products. The former shows complete details of construction features including photos, line drawings and tabular material. The latter is a smaller folder which pictures various items in the line and describes them briefly. Sterling, Inc.

ITEM NO. 192

Heating Products—This 8-page bulletin gives brief descriptions of the many heating products in the company's line. Illustrated and described briefly are convectors and enclosures, unit heaters (floor and ceiling mounted), valves, industrial traps, circulators and fans. Trane Co.

ITEM NO. 193

Radiant Heating—"What We Have Learned from 1000 Radiant Heating Installations," is the title of this 12-page booklet. The booklet starts with the early days (in this country) of radiant heating and traces its growth, both in acceptance and engineering advance, through the years to the present time. The bulletin analyzes the types of installations and shows the various methods of construction and installation. Charts and diagrams emphasize the points brought out. A. M. Byers Co.

ITEM NO. 194

Water Heating—Bulletins SM-4 and SM-5 contain invaluable information on a line of industrial water heaters. Diagrams, subject matter and photographs show how the water heater works. A typical problem is presented and answered. A table in each Bulletin gives a list of ratings and specifications while another shows hot water requirements. A table in Bulletin SM-5 details the thermostatic valve capacities. Both bulletins feature a schematic layout of a steam mixed water heater. O'Brien Steam Specialty Co.

ITEM NO. 195

Gas-Fired Unit Heaters—This eight-page bulletin—AIA File No. 30-C-43—describes the company's gas-fired unit heaters. Complete details of construction are given as are complete tables of roughing-in dimensions. The various types of heaters are described separately with illustrations, tables of capacities, dimensioned drawings and tables of dimensions. Information on selection of sizes and "How to Order," is given. Surface Combustion Corp.

ITEM NO. 196

Unit Heaters—This 8-page bulletin JS20-10M-016, presents complete engineering data on one series of the company's heavy duty floor type unit heaters. Operating data, motor horsepower and air delivery are listed in tabular material and operating data which includes a complete description of the unit accompanied by line drawings, is given in another section of the booklet. Photographs of the unit installed are presented and line drawings show methods of installing duct work for hangars, factories, and similar structures. Other products in the company's line are briefly described and parts of the floor type unit heater are described in detail. Surface Combustion Corp.

ITEM NO. 197

Unit Heaters Bulletin—Bulletin 401 contains 16 pages and describes this company's blower fan type unit heaters. The bulletin is exceptionally well arranged and presents practically every bit of information which is necessary for specifying, ordering and installing the units. Typical of the features of the bulletin are chapters on capacities, conversion factors, dimensions of floor type, wall type, horizontal type and inverted type heaters. Transmission coefficients are presented in tabular form on two pages and piping diagrams are presented on another page. Airtherm Mfg. Co.

MECHANICAL POWER TRANSMISSION

ITEM NO. 198

Speed Reducers—Data Sheet 8974 describes the operation of this company's new cone-drive, fan-cooled speed reducer. The bulletin, besides describing the fan-cooled reducers also shows the manner in which standard cone-drive speed reducers can be converted to fan cooling in the field by a simple addition. Tables showing combined mechanical and thermal ratings, plus detailed information required when ordering reducers are given. Cone-Drive Div., Michigan Tool Co.

ITEM NO. 199

Belting Data Handbook—Engineering data for design and installation are presented in this 23-page handbook by Samuel L. Allen and William Staniar. The book is a spiral bound issue and has innumerable drawings and calculations which are designed to assist the engineer in planning installations. It contains a graphical method for computing the correct overhang of the motor required to transit a given load under all conditions of operation. Also given is a method of figuring belt widths and bearing pressures. J. E. Rhoads & Sons.

ITEM NO. 200

V-Belt Indexed Catalog—A new 144-page indexed catalog for the company's V-belt drives has been issued and is designed to simplify drive selection so that persons who are untrained in V-belt engineering can readily specify the proper drives. Nearly two-thirds of the book is devoted to "pre-engineered" drives for all applications from 1 up to 150 hp. More than 22,000 stock drives are listed in this section. Drives for all horsepowers, motor speeds,

(Continued on page 22)

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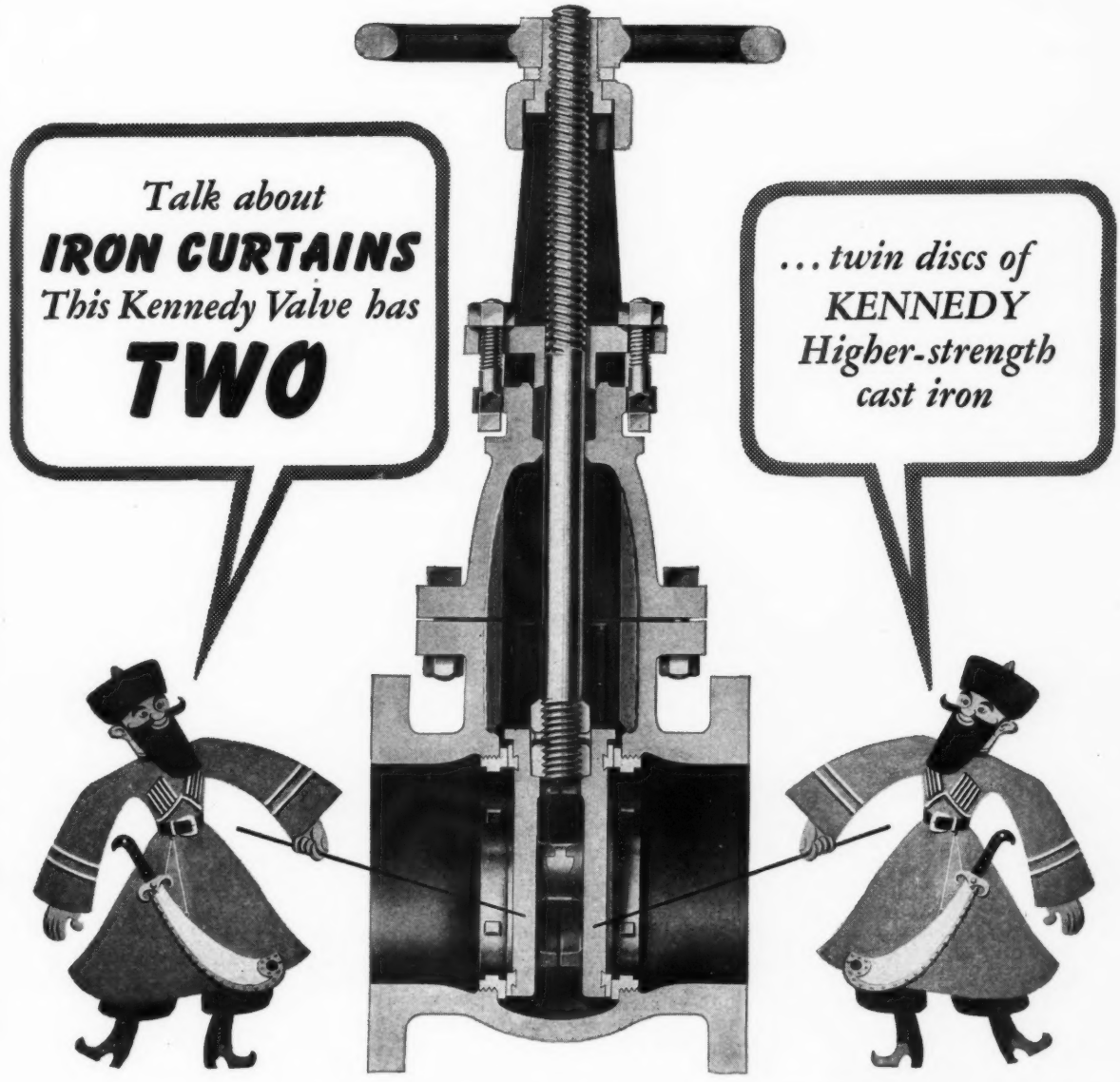

When you close a Kennedy Iron-Body Double-Disc Gate Valve, you drop a *double* iron curtain...twin discs of Kennedy Higher-strength Cast Iron – double assurance of complete closure, even when grit is present in the liquid being handled. As soon as the port opening is completely closed, a wedging device between the discs drives them apart . . . forcing each disc against its seat. If grit is caught on one seat, the other seats tightly.

The lodgment of sediment or the position of the valve will not affect the action of the cams and discs. Operation is perfect with either disc toward the pressure.

Every Kennedy valve...Iron-Body or Bronze...gate, globe, angle or check ...is designed with equal care to give reliable performance in its particular application.

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THE KENNEDY VALVE MFG. CO., ELMIRA, NEW YORK

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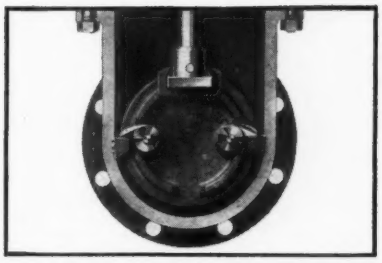
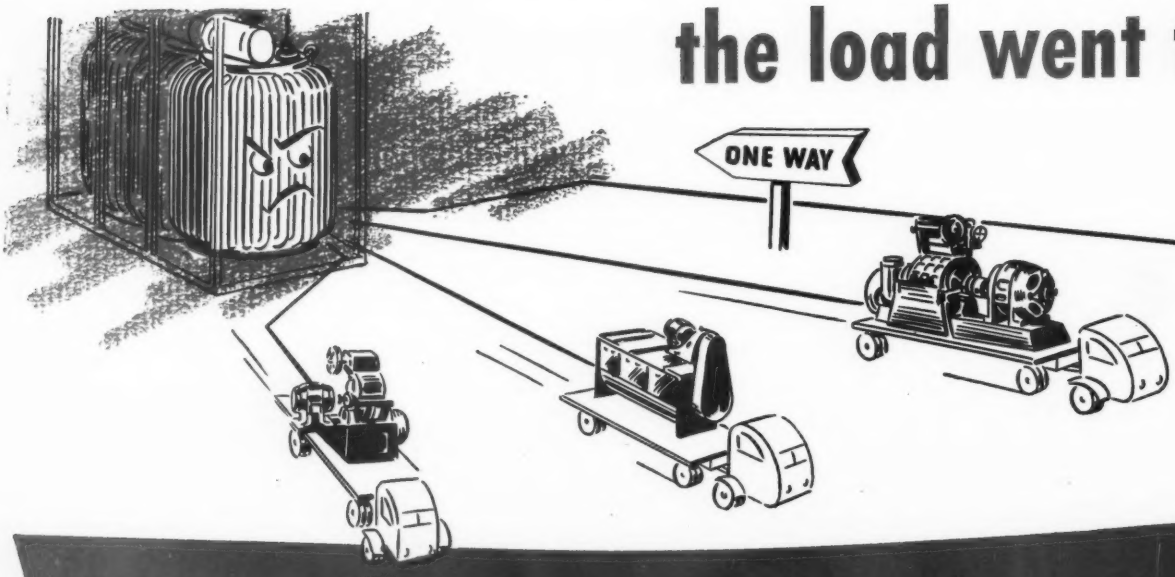


Kennedy Iron-Body Double-Disc Gate Valves are available with non-rising stem or outside-screw-and-yoke, for low, standard, medium or extra heavy pressures, in a full range of standard sizes. The Kennedy 240-page catalog contains full details. Send for your copy today.

KV-177

KENNEDY valves-pipe fittings-fire hydrants



the load went the

This GE Load-center Unit

This G-E load-center unit substation was put on the job close to the center of the shifting load area.

That meant that two more heavy secondary conduits did not have to be run all the way from the main substation, 500 feet away. It meant $1000 for the installed cost of the cable instead of $4000—a saving of $3000.

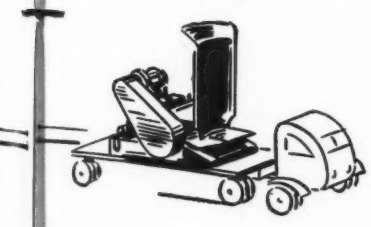
Plant engineers of the Staley Milling Company also credit the substation with eliminating severe—and costly—voltage fluctuations that used to hamper production, What's more, the 13,800/480-volt load-center installation gives them valuable flexibility for future expansion of the power system of this fast-growing plant.

The inherent flexibility of G-E load-center unit substations may offer a dollar-saving solution like this for your next plant distribution problem. When it comes up, get in touch with your G-E sales representative. He will gladly offer recommendations based on General Electric's experience with thousands of plant distribution problems.

Apparatus Department, General Electric Company, Schenectady, N. Y.

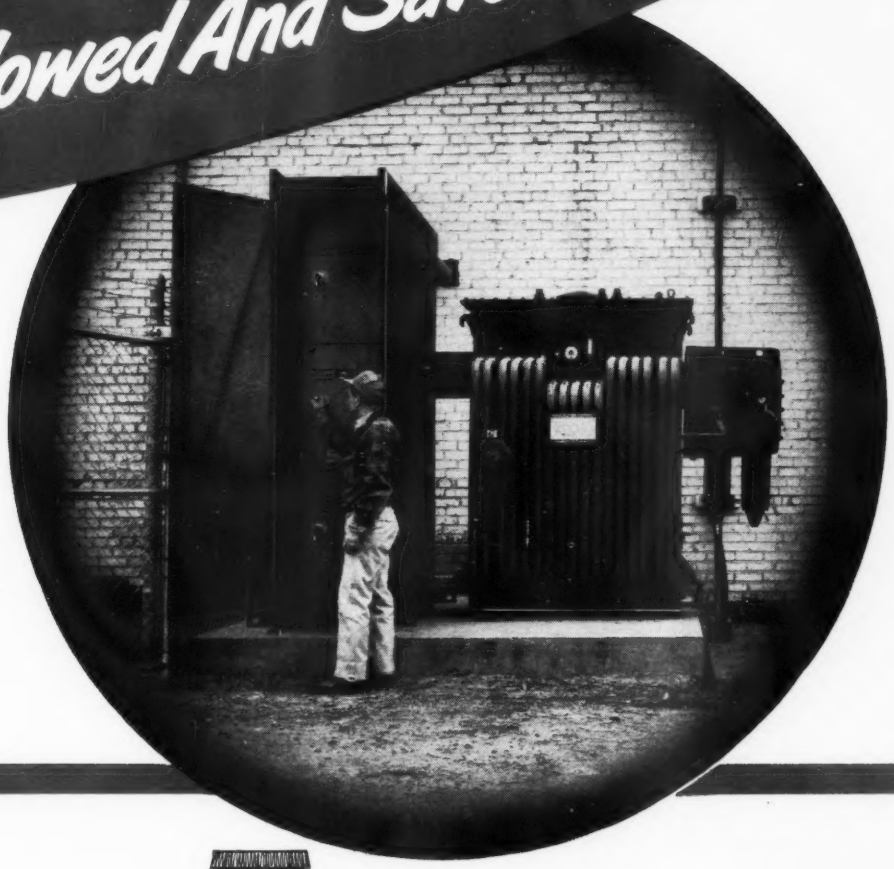
GENERAL ELECTRIC

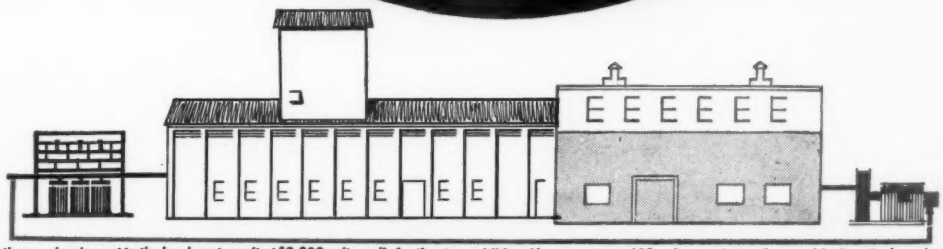
...e 'wrong' way



The electric load moved *away* from the main substation instead of toward it, as originally planned. As a result, heavy secondary conduits reached out 500 feet. New equipment to be installed would have required two more of these heavy secondary cables—at $2000 each.

Followed And Saved $3000!





Power for the new loads went to the load-center unit at 13,800 volts—eliminating two additional heavy-copper 480-volt secondaries that would otherwise have been needed.

Bulletins . . . . Catalogs

(Continued from page 18)

ratios and driven speeds are systematically listed according to horsepower. The "pre-engineering" consists of the calculation and listing of a stock drive to meet a certain set of conditions, including horsepower, motor speed, ratio and overload factor. Allis-Chalmers Mfg. Co.

CLEANING

ITEM NO. 201

Floor Sweepers, Machines—A series of bulletins have been issued by this company on its many floor machines and sweepers. Described are power sweepers, industrial floor machines, industrial floor machines of the steel wool and the wire brush types. Special features of the various machines are covered in descriptive and photographic sections and their uses are briefly outlined. G. H. Tennant Co.

ITEM NO. 202

Portable Vacuum Cleaner—Complete description of a recently-announced vacuum cleaner for industry is contained in bulletin 112D. This 4-page bulletin describes in detail the operation and construction of the unit and lists a table of specifications for 2 models. The booklet is well illustrated. The Spencer Turbine Co.

GRINDING

ITEM NO. 203

Grinding Instructions—"The Know-How of Grinding" is the title of this recently-issued bulletin. It describes and pictures the many booklets and instruction pamphlets which are available from the company and it also presents an order blank for ordering any of the books listed. Another order blank allows the reader to send for a magazine which is published by the company. Norton Co.

ITEM NO. 204

Grinding Wheels—This 28-page bulletin, Form 1052, will provide users of abrasive products with a manual of considerable help in making selections for the more common grinding operations. Grinding wheels of many types, from tool room grinders and cylindrical grinders to weld grinders and saw sharpeners, are described and illustrated. Tables of sizes, abrasive makeup and prices accompany each description. Norton Co.

ITEM NO. 205

Grinding Wheels—"Grinding Wheel Information and Selection" is the title of this 66-page manual which discusses the grinding wheel as a precision tool and tells why a knowledge of grinding wheels is important, also how to order them. Wheel specifications are covered acording to grain size, grade and structure, and the various wheel markings are pictured and explained. The fundamental factors in the selection of wheel specifications such as material to be ground, amount of stock removed, area of contact and type of grinding machine are covered. Factors affecting the selection of a grinding wheel are also discussed. A complete table on grinding wheel recommendations, a table of speeds and many other diagrams and photographs make this a valuable and informative booklet. Norton Co.

MACHINE EQUIPMENT

ITEM NO. 206

Vibration Mounts—There are 8 pages in this recently-issued bulletin on vibration mounts. Sectional views of the mounts are presented and actual installation views are given. A load deflection curve and a table of sizes, models and prices are included. A page of drawings and dimensions is presented on the back of the folder. Hamilton Kent Mfg. Co.

ITEM NO. 207

Safety Guards—Safety guards to provide maximum protection on power presses are described in this new 12-page bulletin. The guard is well illustrated and all of its many features are described in considerable detail. A listing of the advantages of the unit are covered and a dimensional diagram sheet is enclosed. Junkin Safety Appliance Co.

ITEM NO. 208

Power-Driven Brushes—Many types of brushes for industrial application are described in this new 36-page booklet. Excellent photos show the brushes in use and one section of the booklet shows the various types which are available. Methods of attachment of the brushes are covered. Described are the uses of the brushes in such industries as dairies, bakeries, tanneries, textiles and others. Fuller Brush Co.

EXHAUST SYSTEMS

ITEM NO. 209

Industrial Fan Systems—"Fan Systems for Various Industries," is the title of this 32-page bulletin. It describes and illustrates typical examples of blower systems for woodworking industries, dust collecting systems in metal industries, cooling systems for the glass industry and industrial ovens. The need for such systems is explained in each instance and the booklet is well filled with excellent photos of installations. The Kirk & Blum Mfg. Co.

ITEM NO. 210

Dust, Fume Eliminators—Various types of dust and fume eliminations are covered in an exceptionally attractive and informative new bulletin. The booklet shows the application of the units to grinding booths and other places. Various applications are shown in full-page blueprint form. Schmieg Industries, Inc.

ACCESSORIES

ITEM NO. 211

Boiler Tank Accessories—Catalog 11 on forged boiler and tank accessories has just been issued. The bulletin gives complete buying information on manhole and handhole plates and yokes. The 20-page booklet contains illustrations, dimensional drawings, tables of weights and sizes and descriptive information. Comparable designations giving chemical composition and tensile properties of the products are presented. The Steel Improvement & Forge Co.

ITEM NO. 212

Hydraulic Accumulators—This is the story of hydraulic accumulators. The first part of the booklet explains what the accumulator is and how it was developed; the second part gives engineering data and practical applications. Construction details, materials, and principles of operation are also covered. Line drawings and photographs show the different types of accumulators; diagrams show the installation of accumulators in pressure regulator circuits, the accumulator as a leakage compensator, typical installation of accumulators in constant-pressure hydraulically loaded mill roll arrangement, etc. A complete price list also accompanies the booklet. Greer Hydraulics, Inc.

WELDING

ITEM NO. 213

Heliwelding—Form ADG 2030 is a two-color, 8-page folder describing the company's three types of Heliweld equipment—the manual holder, the machine holder and the electronically controlled automatic head. The bulletin lists advantages and uses of the process, construction details of the equipment and a page devoted to supplementary equipment and supplies. Air Reduction Sales Co.

ITEM NO. 214

Low Temperature Welding—Vol. 4, No. No. 9, of "The Eutectic Welder" presents a quick-reference chart for overlaying which shows the correct electrodes to use for different operations under different conditions of service. Photos of actual jobs add value to the chart. Eutectic Welding Alloys Corp.

HOSE, JOINTS

ITEM NO. 215

Expansion Joints—Bulletin EJ-47, 8 pages, contains valuable information on a line of expansion joints used for control of expansion, vibration and misalignment in pipes. Various type joints are illustrated and described. A full page chart gives relative expansion joint data for stainless steel or copper corrugations. Another full page chart shows the thermal expansion in pipe lines. In addition, there is included an expansion joint data chart (flanged ends for stainless steel or copper corrugations. The bulletin closes with a description of the information needed for prompt and accurate expansion joint recommendations and a listing of necessary data for proper ordering. Chicago Metal Hose Corp.

Mark the numbers of the bulletins you wish to receive on the no obligation, no postage card between 18 and 19 and 58-59

ITEM NO. 216

Nickel Alloy Welding—This new 16-page booklet is concerned with the materials required for metal arc, oxyacetylene and submerged melt welding of nickel and the high nickel alloys. Also, it lists such general information as the type of welding rods to use, recommended amperages for electric-arc welding, and the proper flux to select for gas welding and brazing. Information also is included on technical booklets on the subject of welding. The International Nickel Co.

ITEM NO. 217

Flexible Joints—The four pages in this new bulletin give extensive information on the company's line of flexible joints for every purpose from steam heated presses of all kinds to pile drivers and steam jacketed mixers. Photos of actual installations and pictures of parts for the joints are printed. Flexo Supply Co.

ITEM NO. 218

Flexible Joints Bulletins—Bulletins 164, 165 and 167 are small folders, just issued, describing this company's line of flexible joints. Illustrations show the joints installed in many places wherever a flexible or swing pine joint is required. They are designed to convey compressed air, steam, water, gas and other fluids under high or low pressure. Tables and drawings of dimensions of various types are given. Flexo Supply Co.

ITEM NO. 219

Clamping Tools and Fittings—Hose clamping, general maintenance and miscellaneous repairs with this manufacturer's clamp fittings are described in this recently-issued Catalog 235. The bulletin is excellently illustrated with line drawings which show how to make such repairs as clamping split handles, repairing cross arms, clamping guy wire guards, splicing welding cable and many others. Photographs also are used extensively. Punch-Lok Co.

ITEM NO. 220

Flexible Shafts, Machinery—Catalog 47, 32 pages, completely covers the company's line of flexible shafts and machinery such as high speed grinders, grinding wheels, speed changers, polishers, concrete vibrators and grinders and a complete line of accessories for all of this equipment. The bulletin is extremely well illustrated and prices for each item are given. Wyzenbeek & Staff, Inc.

ITEM NO. 221

Files—"There's a Swiss file for every specific purpose" is the title of this 24-page tabloid catalog. It is described as an extremely convenient guide and reference booklet and it lists 3566 patterns, sizes and cuts of band and machine files and riffiers. In addition to this large number of standard files, numerous special files bring the line up to more than 5000 different patterns, sizes and cuts. Grobet File Co. of America, Inc.

ITEM NO. 222

Tools—These two bulletins—F-10 and BE-14—describe, respectively, a reversible ratchet socket wrench and soft-face hammers and mallets. Outstanding features of the tools are pointed out and illustrations show advantages in operation. Prices and dimensions of three different size wrenches are given in tabular form. Greene, Tweed & Co.

ITEM NO. 223

Hydraulic Jacks—Catalog J-46, 12 pages, describes all the features of construction and operation of this company's hand jacks up to 100 ton capacity. The booklet is exceptionally well illustrated with sketches and photos which show operation and exterior construction and interior details of the jacks. Blackhawk Mfg. Co.

MISCELLANEOUS

ITEM NO. 224

Heavy-Duty Coils—Bulletin B-1318 has recently been released. It covers the company's heavy duty coils for industrial and process steam heating. Detailed features of the units' construction is covered by

(Continued on page 64)

LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS

Cool!

THE FIRST COOL OPERATING FUSE DESIGNED BY WARE

A Cool Operator!

WARE HI-LAG Renewable FUSES

To secure adequate protection, yet end needless delays and costly shutdowns, calls for WARE HI-LAG Fuses. Scientifically designed and constructed to reduce excessive heating during "round the clock" schedules, heavy current loads and starting surges.

The construction of WARE HI-LAG Renewable Fuse provides every advantage for maintaining low contact resistance and strong time lag—up to five times normal current.

The Links—the knife-blade assembly—the double bridge supports—the spring tension contacts and greater contact surface are exclusive features which reflect the superior qualities of this amazing cool operator.

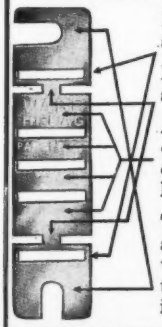
Try WARE HI-LAG on your toughest production line—you'll find what most engineers are daily proving—that their GUARANTEED Performance rates them the Best—Most Economical—and Lowest Cost Fuse to install.

We manufacture all of our own parts and are making prompt deliveries.

Write for Brochure giving detail of all their COOL FACTS, sizes and prices.

Cool Facts No. 1

Strong Time Lag—2 to 5 times normal current, for handling starting overloads and operating surges. Link is one piece of metal, one thickness throughout affording unexcelled time-lag characteristics.



Fast opening on short circuits.

Expansion without sharp bending.

Area to absorb heat of motor starting current and short heavy surges.

Terminals are wide and heavy to provide maximum contact area — reducing heat.

APPROVED BY UNDERWRITERS' LABORATORIES

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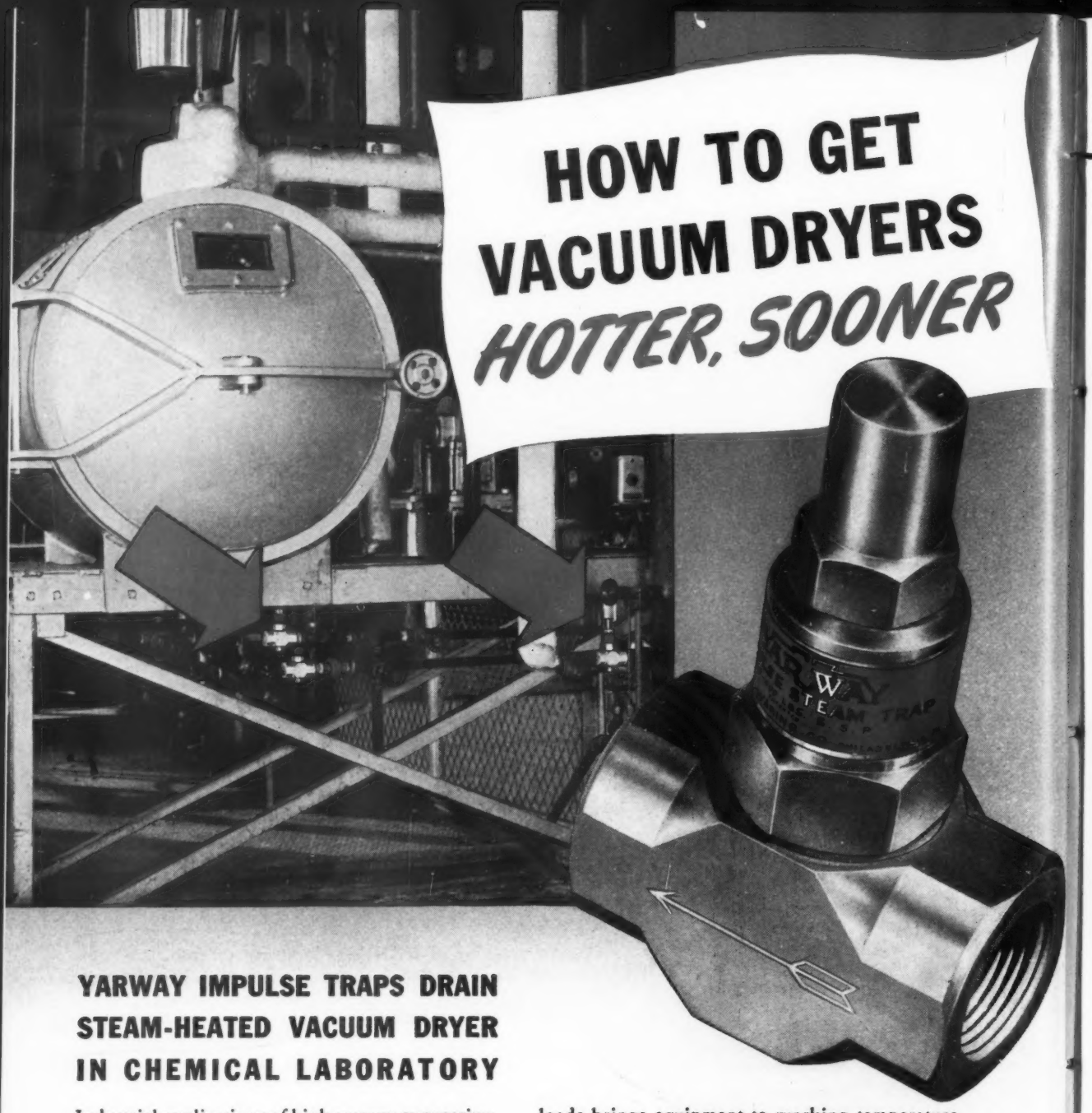

HOW TO GET VACUUM DRYERS *HOTTER, SOONER*

YARWAY IMPULSE TRAPS DRAIN STEAM-HEATED VACUUM DRYER IN CHEMICAL LABORATORY

Industrial applications of high vacuum processing are constantly increasing . . . and so are installations of Yarway Impulse Steam Traps.

Here at the Eastern Regional Research Laboratory of the Department of Agriculture, three Yarways are shown on a steam-heated vacuum drum dryer in the Chemical Engineering and Development Division.

These and nearly 200 other Yarways used on various equipment in the laboratory, are doing a good job . . . and so they should. Yarways are famous for *getting equipment hotter, sooner, and keeping it hot. Continuous* discharge under heavy loads brings equipment to working temperature *sooner;* discharge at *short intervals* under lighter condensate loads *keeps it hot.*

Other Yarway features—one moving part, easy maintenance, small size, easy to install, suitable for all pressures, low price.

Try a Yarway today . . . standardize on Yarways tomorrow. See your local Mill Supply Dealer or write for Yarway Bulletin T-1739.

YARNALL-WARING COMPANY
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OVER 525,000 ALREADY PURCHASED!

YARWAY IMPULSE STEAM TRAP

Plant Engineering *Premiere*

Below. At the Container Corp. of America, Chicago—a discussion of the first issue of PLANT ENGINEERING. Left to right: J. Janicek, Assistant Plant Engineer; K. L. Rice, Publisher of PLANT ENGINEERING; Robert Krause, Mill Manager and Assistant Plant Superintendent; and Don O. Jennings, Plant Engineer

Left. At the Crocker-Wheeler Electric Mfg. Co., Ampere, N. J.—R. G. Spilsbury, Jr., Advertising Manager, receives a first issue from Oscar Wilds, New York Manager of PLANT ENGINEERING. Crocker-Wheeler was the first company to reserve space in the new magazine

Right. At Charles M. Gray and Associates in Detroit, Mich.—C. J. Shower, Vice President, receives a first issue from K. L. Rice. This fulfills a promise made last August to Mr. Shower who is a well known collector of first issues. His collection was started as a hobby in the early '30s and now has 204 specimens

Fig. 1—Left. A cast iron column cap cracked under excessive load and caused eight bays to fail. Deflections which exceed about 1 in. for wood beams are danger signals and call for immediate rectification

Fig. 2—Below. An overload of tons of sugar, automobile parts, and canned goods caused the joisted floors of this warehouse to give way. Indianapolis Times Photo

WATCH THOSE FLOOR LOADS!

Are They Beyond Safe Limits?

By **WILLIAM W. GAYLORD** *Consulting Engineer, Hamden, Conn.*

THE PLANT ENGINEER of any plant where the buildings are more than one story in height must always face this question. The overloading of floors is often quite unintentional as the average workman seems to have little, if any, conception of what will overload a floor. It is not unusual to find floors loaded to more than twice the designed load even when the safe loading in pounds per square foot is posted in plain sight.

Where an area is being regularly used to store stock or work in progress, one of the most effective ways of preventing overloading is to establish a ruling that the height of piles, racks or boxes shall not exceed a figure that has been found safe. Where an area is used for storing widely different materials at different times heights for each class of material stored may have to be established.

Whatever method of limiting floor loads is adopted some one person should be given the responsibility, and necessary authority, to see that rules are strictly enforced if satisfactory results are to be expected.

Many buildings are now being used for purposes far different from those for which they were designed, and heavier machines have been installed to increase production. This usually calls for the storage of more and heavier stock adjacent to the machines and further adds to the chance of overloading the floors. Many of the older buildings of mill type construction now in use were designed for floor loads of not over 125 lb per sq ft and had little, if any, provision for concentrated loads. When heavy modern machinery must be installed in such a building a careful study should be made to determine whether it can be so located as not to overstress the existing structure, or whether it will be necessary to reinforce the floor and supporting beams before the machines are installed. In one such building it was found possible to install several machines weighing up to 14,000 lb on the second and third floors by reinforcing the wooden beams supporting the floors with heavy steel channels bolted to the sides of the beams. In case reinforcing is found necessary and column loadings are materially increased the columns and column foundations must be checked to be sure they will carry the increased loading. This should include a check of the actual size of column footings; as in several cases these have been found to be much smaller than sizes shown on design drawings of buildings.

The multistory reinforced concrete building of flat slab construction is another type of building in which floors are often seriously overloaded. *To the average workman this type of floor appears strong enough to carry any load he can put on it,* so unless definite loading limits are established and enforced, the floor is almost sure to be overloaded.

This type of floor is, of course, designed on the assumption that the loading will be uniformly distributed over the whole area and has a very definite safe maximum load depending on the spacing of the columns, the depth of the slab and the amount and location of the reinforcing steel. There is no way of telling from the appearance of such a floor the load for which it was designed so the designed safe loading should always be posted. This type of building is not usually designed or suitable for heavy concentrated loads and loads of this type of far less than the total de-

signed uniform load may cause serious over-stresses in some of the reinforcing steel.

In a case recently investigated two machines weighing between 10,000 and 12,000 lb each had been installed on the second floor in the end bay of such a building. These machines had been so placed that their total load was carried by the main band of reinforcing steel between the exterior and first interior columns and both machine bases overhung the edge of this band to a considerable extent. The total load on these two bays, including machines and work in process, was less than 50 per cent of the designed uniform load; however, small but definite cracks had appeared in the underside of the slab under one of these machines at the edge of the main reinforcing band. A check of the stresses in this reinforcing steel due to these concentrated loads showed that assuming the load to be equally distributed on all of the rods in the band, they would be stresses from 35 per cent to 40 per cent above the design stress limit. A further check indicated that with the placing of these machines the stress could not be expected to be uniformly distributed on all the rods of the band but would be largely concentrated on a few rods at the edges of the band. Assuming the most probable distribution, the rods at the edge of the band under one machine were stressed up to, if not above, the elastic limit. This was found to be exactly the point where the cracks were observed. This building had columns 20 ft on centers and an 8 in. structural floor slab with 1 in. top finish. The floor was designed for a uniform live load of 200 lb per sq ft based on stresses of 600 in the concentrate and 16,000 in the steel reinforcing rods. The machines causing the overloading had recently been installed to replace older and lighter machines.

If heavy and concentrated loads must be placed on a floor of this type the design of the floor and placing of the reinforcement should be studied so that, if possible, the loads can be so placed relative to the heavy bands of reinforcing steel that the stresses in this steel will not exceed the design limits.

Fig. 3. Twelve men died when this building collapsed. (Milwaukee Journal Photo)

Deflections which exceed about ½ in. for steel or concrete are danger signals

If, as in the case cited above, it is impracticable to relocate the machines so as to bring the floor loading within safe limits some way must be found to support the floor slab from below in such a way as to relieve the overstress in the reinforcing steel. In this case it was found possible to install steel columns, in the story below, adjacent to the concrete columns, which supported heavy steel beams at the under side of the floor slab to take these concentrated loads.

If old machines are to be replaced by heavier machines or if a new machine layout is to be made for any floor above that resting on the ground, the effect of the floor loading should be given careful consideration. Some machines, such as punch presses, headers, etc., cause a considerable impact load on the floor in addition to their dead load when they are in operation and this must be taken into account where this type of machine is installed. Any type of machine transmitting any considerable vibration to the floor structure must also be given special consideration in determining stresses in floor.

If there is any probability that the proposed change will cause any serious overloading, the stresses in the floor and supporting structure should be checked by a competent engineer, familiar with the building construction. If it is found that the proposed loading will cause overstress in any part of the existing building, either the layout should be changed so as to bring the stresses within safe limits, or the overstressed members suitably reinforced to carry the additional load before the equipment is installed. In this way any permanent injury to the building can be avoided and the possibility of serious delays and costly repairs after equipment is installed eliminated.

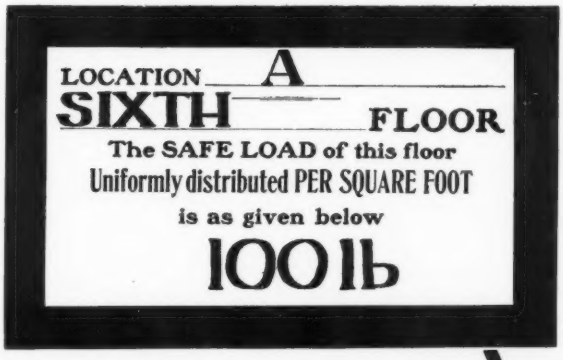
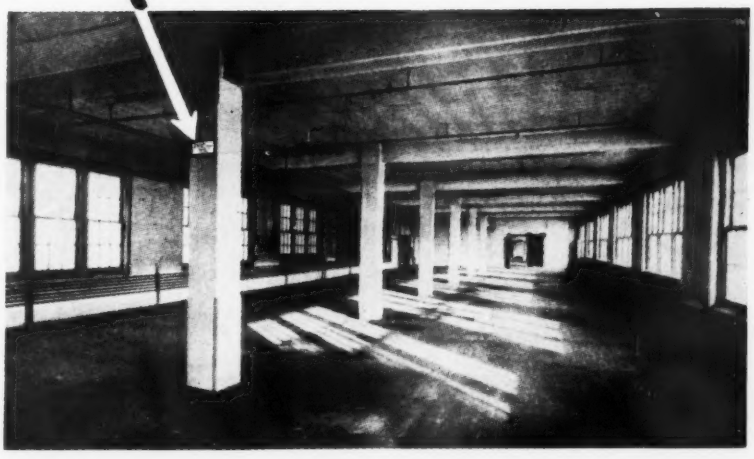


Fig. 5. Recommended floor loading sign to be placed in conspicuous places about each floor. This is the sign used by the City of Chicago



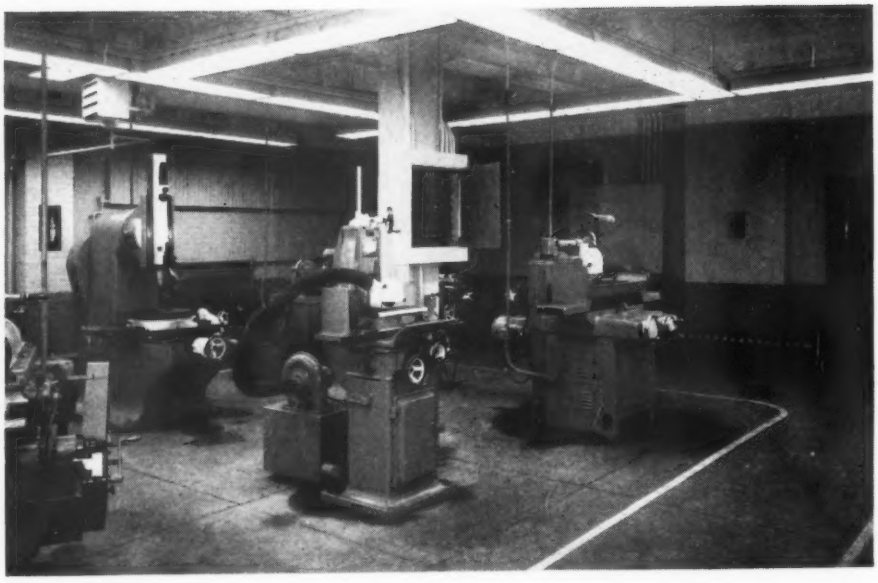


Fig. 1. A color conditioned shop. Machinery is painted in accordance with 3-dimensional seeing principles. Hazards and protective equipment are readily spotted. Extreme contrasts in light and dark have been eliminated, and a uniform seeing environment is created by painting walls in greens. Ceiling is white for maximum light reflection. Highest standards of safety and efficiency can be held

COLOR—The New Worker

The use of color has a marked effect on the morale of factory workers and the efficiency of production . . . Color as a factor in promoting safety . . . Red, yellow and ivory give effect of warmth . . . Blues and greens create feelings of coolness . . . Color also affects maintenance work . . . Color layouts in plants

By THOMAS TRAIL

MILLIONS OF DOLLARS have been spent by industry on time-and-motion studies to minimize body fatigue. But until late years little has been spent to save workers from eye fatigue, except for improved illumination.

Often the changes recommended by time-and-motion engineers seem trifling. Perhaps the handle of a shovel is made slightly shorter or the stool that a worker sits on may be raised an inch or two. Yet the productivity of the man who uses that shovel or stool is increased by ten or fifteen per cent.

The history of modern industry is filled with examples of trifles that have proved to be of tremendous importance.

The new science of the utilization of color in industry deals with one of these tremendous trifles—color! It may be hard to believe that the color on a machine or wall can have a marked influence on a worker's morale or his rate of production. But remember—the executives of other days must have been equally skeptical about the practical value of adding to or subtracting an inch or two from a factory stool.

This is one subject on which management and labor can see eye to eye, since both benefit. From the standpoint of the employee, the purpose of color planning is to make his work easier, to make him happier on the job, and to contribute to his safety. Management's benefits include increased production, lessened employee fatigue, and reduced absenteeism and employee dissatisfaction.

For this reason such a program should be considered in the light of an investment, not as an unnecessary expense. It is an investment in increased production and in the employees' health. It is no less an investment than would be made in improved machinery or in health and accident insurance.

This science is modern but it is not new. It was first inaugurated in 1941, and has since been adopted by thousands of plants throughout the country.

Today planned color is being put to work in such progressive plants to enable workers to see better and to work faster. By utilizing certain color combinations that science has found provide restfulness and seeability, forward-thinking executives improve the morale of their employees and at the same time step up production.

It has been found that when machines, for example, are painted a dull, drab color it is difficult for workmen to distinguish clearly and, as a result, precious time is lost in fumbling, and the danger of accident and injury to the worker is increased.

The purpose of this new science of color is to plan such combinations of color as will provide the greatest amount of contrast without causing eyestrain, fatigue or depression. The various parts of a machine are painted in the colors that will enable the operator to distinguish more easily, yet will be restful to his eyes and nerves.

Furthermore, by painting machinery and surroundings in bright, light-reflecting colors, lighting is improved and strainless, full-vision is made possible. The result is that production is increased, rejects are cut to a minimum and accident hazards are reduced.

This planned color utilization is not the result of haphazard guesswork.

Paint technicians collaborated with lighting engineers in a thorough investigation of the matter. It was found that where ferrous metals were being machined the ideal color for "spotlighting" the working area of the machine was a special buff. Where brass, leather or other buff-colored materials were being worked it was found that a special green would provide the ideal contrast to the buff.

Going a step further, the rest of the machine was painted a restful green or a medium gray color to provide light-reflection. The result was that these color combinations attracted the eye instantly and clearly "spotlighted" the danger point, without being so abrupt in contrast as to be uncomfortable.

These theories were further tried out on a large scale in several manufacturing plants to determine their everyday workability. Various types of manufacturing were chosen for these test applications and in every case a noticeable improvement in the visibility of the workers resulted. In some instances the illumination at the working point was increased more than 100 per cent.

Executives who tried out this system of painting were enthusiastic in their praise. They reported increased production, accident reduction and a psychological reaction of the employees that resulted in their taking pride in their machines and keeping them neat and clean.

Color planning takes into consideration other factors as well. By painting walls, floors and ceilings in colors that reflect light but do not cause glare, the efficiency of the plant lighting system is greatly increased. This results in a definite reduction of wasted electricity. Furthermore, it has been established that environment directly affects production, employee morale, absenteeism, safety and good housekeeping. Colorful surroundings provide an atmosphere that is psychologically pleasant. Work areas are thus made attractive so that they stimulate and keep the employee in an agreeable frame of mind. New employees are given a favorable first impression and labor turnover is reduced to a marked degree.

The painting of floors in suitable light-reflecting colors contributes to safety by causing tools, scattered debris, oil, etc., to stand out in sharp contrast, thus reducing the hazard of falling, stumbling or slipping.

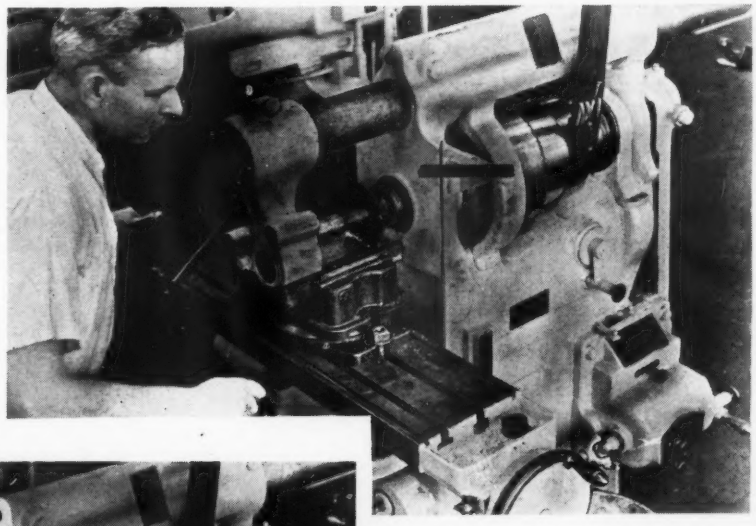
This painting procedure also discourages littering, and results in good housekeeping.

The scientific application of color in industry is definitely not intended as a means of glamorizing plants. Instead, color becomes a worker with definite functions to perform. This science is based upon proven theories of good seeing. Where the employee works amid dull, drab surroundings his eyes are subject to unnecessary strain in an effort to see. He cannot clearly distinguish between fixed and moving parts of machinery, nor can he tell just where the material he is working on ends and the machine begins. Furthermore, he may have bright-colored distracting objects directly in his line of vision, or light reflecting from nearby surfaces may cause uncomfortable glare. All these things contribute to inefficiency.

But where coordinated, planned colors are utilized all these drawbacks are eliminated, and, going a step further, colors of surroundings are selected with a definite view to improving the psychological comfort of employees. For example, where working areas are chilly and vaulty the use of red, yellow and ivory give the illusion of warmth and sunlight.

Color can similarly be used to create a feeling of coolness in hot, stuffy work areas. Blues and greens are used for these purposes.

Where ceilings are filled with a clutter of braces, wires and pipes they seem to crowd down on the worker. By utilizing a light blue color, in cases where light-reflection is not a prime consideration, the illusion of lightness is created, making



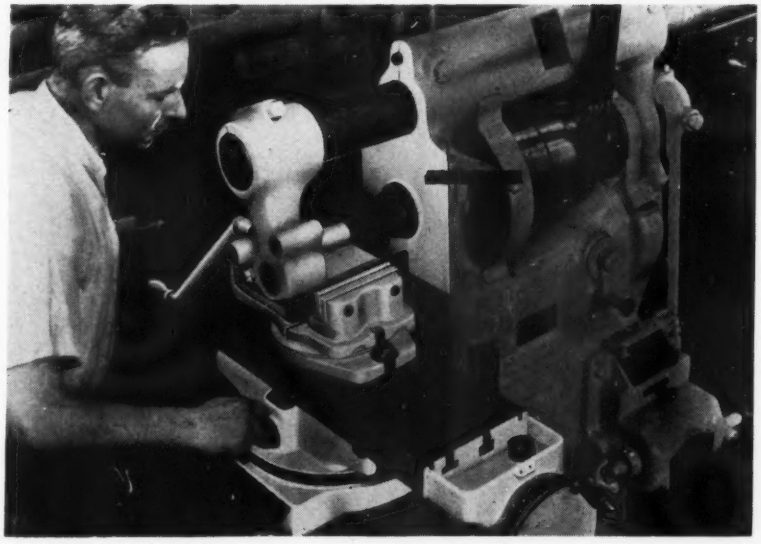


Fig. 2. (Above) BEFORE being given a 3-dimensional seeing treatment, this machine was the same drab, dull color as the material being worked. This "camouflage" delays production and results in mistakes and personal injuries

Fig. 3. (Left) AFTER the body of the machine is painted with "horizon gray" and the working surfaces with a contrasting hue, such as "Spotlight Buff" the "camouflage" is removed and the material being worked stands out in sharp contrast to the surroundings

Fig. 4. The modern machine shop furnishes continuous row fluorescent illumination which is utilized to the maximum degree because of the light reflecting surfaces provided throughout. Added aid to good vision is the "3-dimensional seeing" treatment of all machines. This finishing system calls for light instead of dark gray over-all, with the working area painted buff

the distracting ceiling seem to recede, and giving the worker more apparent space and air in which to work.

Color also directly contributes to safety in pointing out dangerous conditions. For example, by painting the inside surfaces of machinery guards orange, whenever the guard is removed from the machine its bright, noticeable color will call attention to the danger present. Likewise, by using blue on all operating levers, switch boxes, etc., attention is immediately called to the necessity for caution. Aisles in plants, as well as moving trucks, cranes, conveyors, etc., when painted in attention-attracting colors, warn the employees of the danger of being in the vicinity of these objects.

Of course, in following such a plan of scientific color selection many other factors should be considered if a practical and efficient system is to be achieved. Durability of the paint finish must be considered as well as the practical aspect of the selected colors. Very light and very dark colors are most easily soiled. Medium gray tones conceal soiling. This lightens maintenance work.

Since so many complex factors enter into the practical application of the science of color utilization in the industrial field, it is highly advisable that engineers schooled in this science be consulted. They are fully equipped with the knowledge and the facilities of laboratory technique to enable them to advise a practical plan for color utilization. A color selector enables the engineer to determine just what color should be used where a particular material is being fabricated to provide the most desirable hue contrast for the working areas of machinery. He is also equipped with a chart to show the proper ceiling, wall and floor color combination to be used in a particular environment or location. Charts explaining what colors should be used and where on representative machines used in industrial plants have been prepared. These enable the color engineer to recommend a complete layout, tailored to fit the particular industry being considered and based upon proven scientific and practical data.

The psychological effect of color is very much like the physical effect of drugs. Color, like drugs, should be administered in the right doses for producing the desired effect. In colors, as in drugs, there is danger of overdosing, as well as of weakening. The mixture of white with color is analogous to water dilution in internal medicine. Grey and buff have a certain emotional effectiveness, although the basic hues cannot be identified. Usually, grey is cold and produces a sensation of neutralized blue. Buff is warm and produces a sensation of neutralized red and yellow.

To aid executives and others interested in this science to understand better its manifold advantages, motion pictures are available that describe the principles of light and color.[1]

In the past such improvements as better lighting, improved ventilation, planned safety and health programs, have paid dividends to the plants that were far-seeing enough to adopt them. Production increased and employee morale and satisfaction was improved. Now color has entered the industrial field, and progressive executives who seize upon this modern advancement will reap rich rewards in further increased production, and at the same time will benefit their employees.

[1] These motion pictures are available upon application to E. I. Du Pont de Nemours & Co., Wilmington, Del.

[2] All photographs in this article furnished by courtesy of E. I. Du Pont de Nemours & Co.

Fig. 5. Another machine shop with the machines properly painted in colors

Paint Can Solve Many Problems in Industry

Importance of cleaning surface prior to painting . . . Protecting machinery from oil and grease . . . Painting hot surfaces . . . Mixture for painting nuts and bolts . . . Paint before insulating . . . Corrosion protection for water tanks . . . Acid resisting paints for ammonia compressors . . . Fungus resisting coatings . . . Proofing masonry walls . . . Utility and decorative paints for floors . . . Paint has insulating properties

EVERYONE knows the value of paint on wood and metal to prevent rot and rust. It is the correct selection of the cleaning method, primer coat and the paint to be used that count in determining the time between paintings.

It will do little good to paint a surface if it is not cleaned properly first. The methods used for cleaning will vary with the condition of the surface, the previous coating, and the material itself, wood; metal, galvanized or not; concrete. Each of these materials must be cleaned in a different way because the porosity varies so much. For instance, wood can be cleaned with a wire brush, sandpaper, blowtorch, chemical paint remover, or just plain strong soap. The method of cleaning that can be used on concrete is a wire brush and a chemical paint remover, aside from the more expensive but more effective sandblasting. Metal, depending on its surface hardness can be cleaned in many ways. The main thing with metal is to get all the rust off and immediately coat it with a rust inhibitor.

This is a necessary operation because the moment the bare clean metal is exposed it starts to corrode. The paint and cleaning compound manufacturers can be consulted for the best way to clean various surfaces.

There are many problems in industry that can be solved by the correct paint properly applied.

Machinery, especially production machinery, is very costly equipment and it has to be protected against surrounding conditions. Since oil is used on most of these machines the surface should first be cleaned thoroughly and a suitable primer applied. Then a good grade of machinery enamel or asphalt aluminum paint laid on over the primer.

Where the surface is hot all the time or varying in temperature the heat resisting aluminum paints will serve well unless the temperature is above 1000 F. This would make it a good coating for boilers, burners, furnaces, or ovens. It would also serve well on piping.

Machinery which is subject to excessive heat such as steam cylinders and heads, should not be coated with ordinary paint. It soon discolors and makes maintenance work difficult, causing additional labor of clean-up or repairing. To protect these machines and make them look like machinery, they should be painted a mixture of powdered graphite, cylinder oil, coal oil thinner, and colored with prussian blue. This will afford a protective coating and, at the same time, keep nuts and studs lubricated in a manner so they will come adrift with the use of a normal wrench.

The use of paint on hot piping before the insulating material is applied is recommended. Either an aluminum or bitumastic paint will serve well to protect the metal and also as an insulating agent to aid the insulating material.

Where the metal comes into contact with acids or alkali, as in storage or mixing tanks, and piping, the chlorinated rubber types of enamel far surpass all other paints. Where this type of enamel is used a primer with a rubber base is necessary to assure good binding.

Bakelite paint has been used successfully for coating the inside of water storage tanks where corrosion has been exceptionally bad.

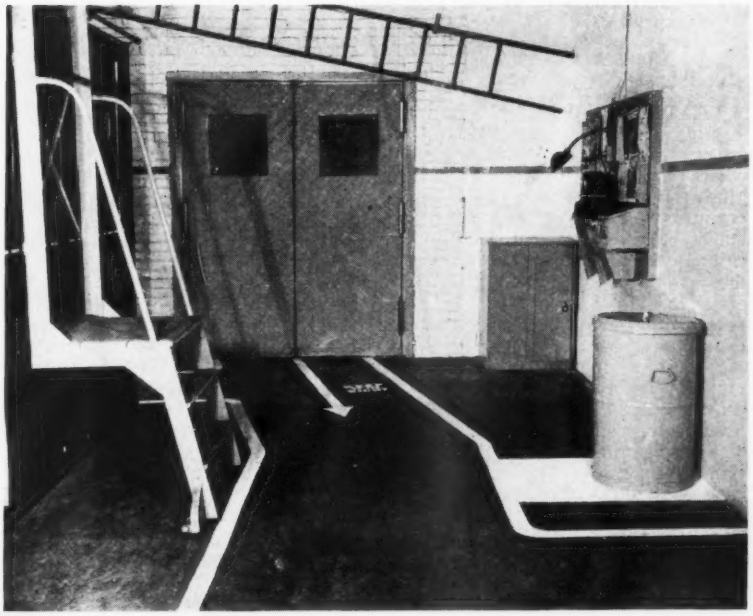
For use around refrigerating machinery and piping a good spar varnish or clear enamel will be found satisfactory where the finish is not subjected to a constant bath. Asphalt and aluminum paints will withstand heavy concentrations indefinitely.

Refrigerating men who have trouble with ammonia should try one of the special acid resisting paints in combination with the compound that is to be used with it and sold together if requested.

Sulfur is bothersome to many plant engineers and power engineers. Each has his own special equipment to consider treatment for. Wet coal can give off sulfur that will corrode bins and conveyors badly and in a short time. These conditions can be remedied by getting information direct from the paint manufacturers, not from the paint store nearby.

On those installations that are persistently troubled with mold it is sometimes good practice to add fungicide to a good grade of paint and apply liberally.

Paint does insulate some but is not to be thought of in the same way that asbestos or cork are considered. But paint does have very definite insulating properties insofar as masonry or



Color makes the movable ladder, trash can, doors, time clock, and fire ladder strike the eye and clearly outlines traffic lanes as an additional safety measure

concrete walls and floors are concerned. This is true because the paint seals the pores of brick or concrete and prevents the moisture from coming through and moisture is an excellent conductor of heat and cold. In this manner paint also acts as a humidity control.

Paint on Masonry

Under the classification of masonry is included brick, concrete, stone and cinder-concrete block. All of these materials are porous and their treatment with paint is highly desirable and beneficial. But it has always been a problem to develop the right paint or coating that will keep the moisture in its proper place.

Cement water paints are satisfactory for finishing walls unless the concrete was poured against oiled forms. The method of application, the curing, and the temperature and humidity have more to do with the effectiveness of this paint than the composition as long as the Portland cement content is not less than 65 per cent. Stiff bristle brushes of the scrubbing type should be used so that the mixture is worked into the pores thoroughly. If it is intended that organic coatings will be applied on top of the cement water paint it is well to mix sharp sand into the primer coat to improve the durability of the organic coating.

For the man who cannot wait very long, the synthetic-rubber paint can be applied sooner than any other. Since it is difficult to obtain synthetic-rubber paint it will probably be necessary to use the next best which is resin-emulsion paints. These paints are easily brushed or sprayed on damp or dry walls and provide good coverage. Three weeks should be allowed for new masonry walls to dry before application of this paint.

Paint for floors is sometimes a tough problem. It depends mostly upon whether it is desired merely to decorate the floor or to actually protect it. Decoration can be done by mixing a dye with the concrete as it is mixed, some hardening compound will also help the paint to hold its color. But the protection of floors is not so simple. The amount and kind of traffic that bears on the floor has the greatest effect. It is some times necessary to apply as many as 6 coats to a floor.

Aisles can be painted a darker color than the surrounding floor and bordered with red or white lines. Workers will automatically stay with in the borders and away from the machinery. Any moving equipment about the plant should be painted in bright colors so that they hit the eye with an impact that warns.

Machinery should be finished in three color finishes. The background, or main body, being in a dark green or buff, the control and moving parts in red or yellow, and the parts holding the material being worked on a color that contrasts sharply with the color of the material.

Another use for colored paint is for identification purposes. Many plants have regular color codes set up and it is easy to tell what a pipe or hose is carrying or what a tank contains. Much has been written on this subject but no national code has been set up. It is up to the individual user to select his own code to fit his plant and processes.

How to Insulate Plant Equipment

Reasons for good insulation program . . . What such a program should consist of . . . Correct application of insulation to pipelines . . . Installation on bent piping and large pipes . . . Insulation of tanks, heaters, drums and other pieces of plant equipment . . . Weatherproofing and protection of insulation jobs . . . Necessity of setting up insulation maitnenance procedures . . . Recommended thicknesses for various operating pressures and temperatures

By UTLEY W. SMITH, ***Manager, The Magnesia Insulation Manufacturers Assn.***

HEAT INSULATION plays an important role in the efficient operation of processes and equipment wherever thermal energy is utilized. Many processes require precise temperature control of materials and equipment; heat losses through uninsulated or inadequately insulated flanges, valves, and other fittings can cause trouble in controlling the temperature and may make necessary an excessive amount of heat input. Piping that is inadequately insulated may develop a steam hammer due to condensation with resultant corrosion or other severe damage to the lines. The prevention of steam condensation is especially important in the case of steam driven equipment; wet steam causes power losses, unnecessary wear, and possible damage to the equipment itself.

An insulating program should consist of three steps. First, selection of a material suitable for the temperature range used in operation and in the most economical thickness for the conditions involved. Second, application of the material in the proper manner, and third, maintenance of the insulation under all operating conditions.

An efficient insulating material for temperatures up to about 600 F is 85% Magnesia. Its thermal conductivity is low. It can be shipped, handled and applied without excessive fracture or breakage. It does not disintegrate, or "powder," when subjected to intermittent or continuous vibration, a particularly important characteristic when rotating equipment, such as pumps, is to be insulated.

Magnesia pipe insulation and blocks do not spall or crack when subjected to alternate heating and cooling, as when equipment is heated and operated hot for short periods of time. Being mineral in nature, the material is nonflammable.

Where operating temperatures range from about 600 F to 1900-2000 F, high temperature insulation such as diatomaceous silica is used. However, high temperature insulation is more expensive and its thermal conductivity is not as low as that of 85% Magnesia. It is therefore used in combination with the latter, the high temperature material being applied directly to the heated surface in a thickness sufficient to reduce the temperature at its outer surface to below 600 F, and the magnesia is then applied.

This pipe insulation comes in semi-cylindrical, canvas-covered sections, three feet long, to fit standard steel, wrought iron pipe, and copper tubing. It is important that the insulation fit as closely and tightly as possible to the surface to be protected. Therefore, before the insulation is applied, the piping is wiped clean of any dirt or debris. The sections of insulation are carefully fitted to the piping with the side and end joints butted tightly

Fig. 1. This workman is finishing the insulation of valves, fittings and flanges with an application of magnesia cement. The lines have already been covered with preformed magnesia blocks

together. For the usual indoor installation, the outer factory-applied cotton cloth jackets are smoothly pasted down and the metal bands that are supplied with the insulation are affixed.

For double layer construction, the inner layer is securely wired in place and the outer layer is applied in the same manner as single layer insulation would be, with all joints of the inner and outer layer staggered.

Where sewed jackets are desired for protection and appearance, the metal bands are omitted. Instead, a layer of rosin-sized paper is wrapped around the insulation and 8-ounce canvas is stretched over the paper and sewed in place. The canvas is then sized with glue and painted with lead-in-oil paint.

For piping larger than 10 inches in diameter, this insulation is furnished in segmental form without the cloth jackets. Segmental insulation is wired in place in a manner similar to the inner layer of double layer construction.

The outside surface is covered with sufficient insulating cement to point up the joints between segments and troweled to a smooth and uniform surface. Where a hard finish is desired, a layer of asbestos cement is troweled on.

When bent piping is being insulated, the pipe insulation is mitered and cemented to fit the contour of the pipe.

Pipe insulation applied to vertical lines is sometimes supported by means of support angles placed at intervals along the piping. Pipe insulation on flanged piping is cut back so that flange bolts can be tightened or removed without disturbing the insulation.

A small steam line is often run underneath another larger pipe carrying liquids that must be kept warm. Insulation construction should surround both pipes so as to permit the heat to be transferred from the steam line to the liquid line. Half-sections of pipe insulation are fitted to the upper half of the large pipe and lower half of the small pipe. On the two sides, blocks of the proper thickness are carefully fitted between the edges of the top and bottom sections of pipe insulation. The two half-sections and the side blocks are then firmly fastened in place with iron wire. All joints are pointed up with asbestos cement, and the entire outer surface covered with a layer of the cement reinforced with hexagonal wire mesh and troweled to a smooth, hard finish. On indoor installations a sewed jacket of 8-oz canvas is then applied over a layer of rosin-sized paper. Where lines run outdoors, an asphalt saturated weatherproof jacket is used.

On piping 3½ in. in diameter and smaller, all valves, flanges and fittings are insulated entirely with an insulating cement. On piping 4 in. and larger, the bodies of flanged fittings and valves, the entire surface of screwed fittings, the entire surface up to the bonnet of screwed valves, and flanges are insulated with block insulation. After the blocks have been wired on as in the case of regular pipe insulation, asbestos cement is applied and finished with a pasted-on cotton cloth jacket.

Insulation of Equipment

Oil and feed-water heaters, drums, superheater headers, and risers of steam generating equipment, separators, storage tanks, steam-air ejectors, and other large equipment are insulated with block forms. The blocks are secured to the metal surface with wire cables and iron wire lacings. When two layers are necessary, the joints of the outer layer are staggered with respect to the inner layer. All joints are closed and made tight and, when necessary, filled in with insulating cement. Hexagonal wire mesh is stretched and secured over the insulation and finished with asbestos cement applied in two coats. The final layer may contain portland cement if a hard finish is desired.

Magnesia blocks make an effective insulation for ducts, flues or breechings that carry hot gases. Because they present a hard surface and a firm structure as a base for cement, a neat looking, smooth finish and a permanent structure can be obtained. If the surface has closely spaced projecting angles or other stiffeners, metal strips or heavy iron wire fabric should be attached directly on the

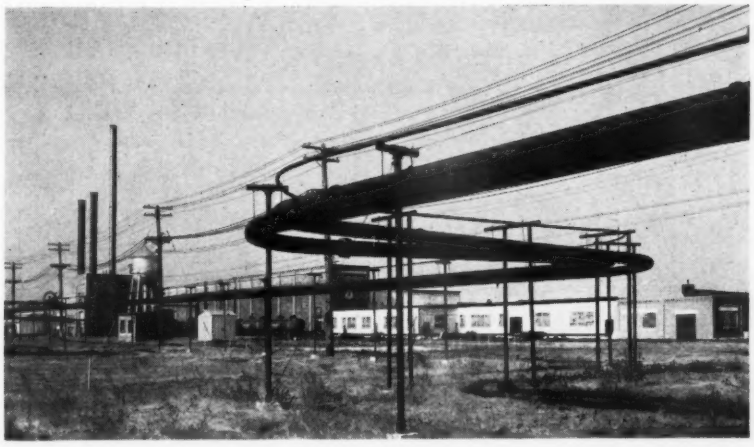


Fig. 2. These outdoor steam lines have been insulated with 85% magnesia and are protected with a weatherproof jacket of asphalt saturated roofing felt

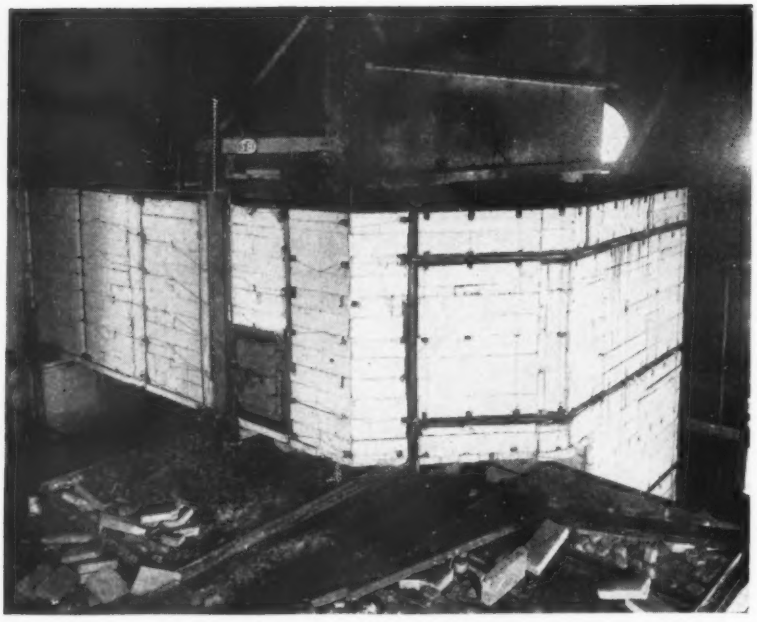


Fig. 3. The magnesia blocks have been applied to this Connery flue. After wire mesh has been applied the blocks will be covered with cement

projections to form a continuous and unbroken flat base to which the blocks can be wired. Where stiffener angles or projections are spaced far apart, additional supports should be placed between the original stiffeners to prevent the wire fabric from sagging.

Insulation of equipment located outdoors must be protected from the effects of rain, sleet, snow, so that its insulating efficiency may be unimpaired. Pipe insulation is protected by a weatherproof jacket consisting of asphalt-saturated asbestos felt which is wired on over the factory-applied cotton cloth jacket. Generous laps are provided at all edges and sealed with asphaltic lap cement. All longitudinal laps are located on the side of the pipe and turned downward so as to shed water.

Instead of the final cement coating used on indoor installations, flanges, fittings, valves, and equipment surfaces are finished with an asphaltic weatherproof compound, which is lapped generously and sealed over the weatherproof jacket of the adjacent piping.

It should be emphasized that insulation is a valuable piece of plant equipment and deserves the same thorough inspection and maintenance as a boiler. The losses resulting from insulation in need of repair may not be as readily apparent as the faulty functioning of a machine, but they are there nevertheless. For instance, the heat loss from a pair of bare, standard, 10-in. flanges on a 150-psi steam line is equivalent to more than one ton of coal a year. The value in dollars and cents of the heat saved by the use of standard thick 85% Magnesia insulation is shown in Table I.

A complete plant checkup should be made to determine whether there are any lines, flanges, fittings or equipment on which the insulation is damaged. Sometimes construction workers inadvertently damage insulation with scaffolding, while installing new equipment. Some insulated surfaces may have been damaged by passing mobile equipment or dropped tools, or because they have been used as supports for ladders. During especially severe weather, weatherproofing may have been ripped off with resultant damage to the insulation underneath.

Damaged insulation should be sawed off and the section replaced with a new one of the same shape. The new piece should be wired on securely, cracks filled with insulating cement, and the protective jacketing replaced. Torn weatherproofing should be removed and new material applied in the same way as the original. Be sure the insulating material underneath is in good condition before applying the weatherproofing. If the cause of the mechanical damage cannot be eliminated, it is desirable to use a metal, protective jacket such as galvanized iron on the insulation. It is necessary to cover only that portion of the pipe or equipment surface that is exposed to damage, such as surfaces at floor level or near stairways.

Excessive vibration of equipment due to bolts or tie rods that have become loose may cause the insulation to loosen with subsequent decrease in insulating efficiency. If the condition is not corrected, serious operating difficulties may arise. The vibration should be eliminated if possible, and the insulation should be removed, reapplied and tightened. The joints should be pointed up with cement and the canvas or other jacketing should be replaced and securely sealed.

It is desirable to check operating temperatures in various parts of the plant against the type and thickness of insulation used. Often, process modifications result in a great enough change in operating temperature to make it economical to add more insulation.

Table I. Monthly saving in dollars and cents by use of standard thickness magnesia insulation on piping, per 100 linear feet of steam pipe

Nominal Pipe Size	Insulation Thickness	5-lb Steam Pressure	10-lb Steam Pressure	50-lb. Steam Pressure	100-lb Steam Pressure	150-lb Steam Pressure	200-lb Steam Pressure	200-lb Steam Pressure 100F Superheat
½"	⅞"	$ 1.94	$ 2.12	$ 3.45	$ 4.48	$ 5.49	$ 5.92	$ 9.61
¾"	⅞"	2.42	2.67	4.36	5.61	6.60	7.40	12.00
1"	⅞"	3.03	3.34	5.40	7.00	8.25	9.25	15.00
1¼"	⅞"	3.86	4.24	6.86	8.85	10.40	11.70	19.00
1½"	⅞"	4.38	4.82	7.80	10.16	11.80	13.30	21.60
2"	1⅛"	5.54	6.12	9.82	12.70	15.00	16.80	27.20
2½"	1⅛"	6.67	7.33	11.80	15.20	17.90	20.10	32.90
3"	1⅛"	8.07	8.90	14.30	18.40	21.80	24.40	39.60
3½"	1⅛"	9.17	10.05	16.20	20.90	24.60	27.70	45.00
4"	1⅛"	10.40	11.40	18.40	23.70	28.00	31.40	50.80
5"	1⅛"	12.60	13.90	22.20	29.00	34.20	38.40	62.40
6"	1⅛"	14.90	16.40	26.50	34.20	40.40	45.40	74.00
8"	1¼"	19.40	21.20	34.50	44.60	52.50	59.00	96.90
10"	1¼"	23.90	26.20	42.30	55.00	64.60	72.60	118.00
100 sq ft 1" thick block insulation with ½" asbestos cement finish		8.70	9.96	15.90	20.60	24.20	27.10	44.00

These savings are based on pipes carrying steam 24 hours per day and 30 days per month.
Coal is figured at $8.00 per ton, delivered, with 13,500 Btu per lb. Boiler efficiency is calculated at 75 per cent, air temperature 75 F.
*Greater thicknesses (1½", 2", double standard or 3") show greater savings and must be considered in selection of economic thickness.

Modern Mechanical Transmission

How to Install and Care for Chain Drives

Paralleling shafts and alining sprockets one of first measures . . . Correct installation of chains on sprockets decided by direction of drive . . . Method of connecting rocker joint chains . . . Advantages of vertical or inclined drive . . . Adjustments of shaft and center of chain make drive more flexible . . . Proper lubrication of slow speed, medium speed and high speed drives . . . Set up inspection routine to protect chains and sprockets . . . Dangers of underchaining . . . Check lists for possible causes and cures

CHAIN DRIVES, like belting, actually are classified in the field of power transmission as flexible connections and their installation incurs fewer difficulties than generally will be encountered with the rigid types of transmissions. There is, nevertheless, still a definite need for the practice of utmost care in their installation, maintenance and lubrication. This article will review briefly some of the important points which should be considered in any maintenance schedule, measures which are nearly axiomatic and yet which are often neglected.

The shafts on which the sprockets are to be installed must be well supported by suitable and rigidly mounted bearings and the sprockets should be installed as close to the bearings as practicable in order to give the greatest possible support at the point of heaviest load.

Shafts must be parallel and sprockets must be in alinement or excessive chain wear and early failure may result. The use of a spirit level is recommended to make sure that shafts are horizontal. Next, measure the distance between shafts on both sides of the sprocket; if the distance is the same and the level indicates that the sprocket is not tilted, the installation is correct.

The chain should be placed on the sprocket so that it will run in the direction of the arrows on the outside links. On drives which are reversing the chain should be so installed that the arrows are running in the proper direction when the heaviest load is being carried. Another point of extreme importance in the installation of chain drives is the amount of slack given the belts. Chain belts, unlike other belts, should not be tight around the sprockets because the working parts are then subjected to a much heavier load than is necessary. Do not give them too much slack, either. On long centers particularly, too much slack will reduce the life of both chain and sprocket and the loose chain will cause vibrations and chain whip.

The usual method of connecting rocker joint chains is to bring the two ends together at the top of the larger sprocket in mesh with the sprocket teeth. The teeth will hold the links in position while the pins are being inserted. The guide links must always be in line when the ends are fitted together. Once the ends are joined in this manner a round point drift pin, inserted through the link apertures, may be used to line up the links. A washer should then be placed on one end of the seat pin before it is inserted in the chain.

Fig. 1. A round point drift pin may be used to line up the links while the pin is inserted on the other side and driven through

Now, with the seat pin and rocker pin in correct juxtaposition insert both pins and drive them in; this will, of course, drive out the drift pin. Place a washer on the other end of the seat pin and rivet both ends over the washers. Back up one end while riveting the other. One precaution to be followed is to make certain that the rocker pin is not inserted backwards.

Whenever there is a choice of shaft positions it is best to use the horizontal drive. This is desirable because the weight of the chain acts automatically as a chain tension adjuster.

When it is impossible to use a horizontal drive the next best arrangement is an inclined drive at an angle of not more than 45 deg from the horizontal. Drives which are vertical or those having very short centers require closer adjustment than drives with reasonable center distances and should be avoided if at all possible.

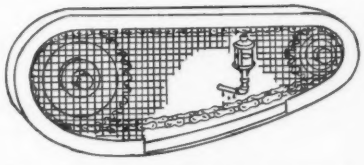


Fig. 2. In the lubrication of medium speed drives drip sight oilers have proved adequate

Due to the fact that new chains may be of the correct tension when first installed and later become too loose for proper operation it is best to have a center adjustment wherever possible. This will permit convenient take-up slack as the chains become run in. Adjustment is particularly important on vertical center drives and if not available an idler should be provided on the slack strand of the chain. Another take-up adjustment it is advisable to provide for is a movable shaft. This permits

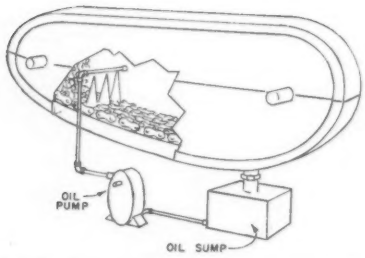


Fig. 3. Proper lubrication of some high speed chains requires a forced feed circulating pump system. The pump keeps the oil circulating and discharging continuously to the inside of the chain so that it is thrown outward through the chain

the adjustment of the distance between the sprocket centers to secure the proper tension on the chain. The amount of adjustment should not be less than 1½ times the pitch of the chain except for very short centers. When small wheels are used on horizontal drives it is preferable to have the bottom strand slack for otherwise the chain may be damaged by the top strand slapping the lower one.

Equally as important as correct installation is an adequate and continuing lubrication schedule. The dusty and dirty conditions under which many slow speed drives operate plus the fact that the slow speed drive is seldom enclosed makes proper lubrication difficult. Heavy oil applied to the outside of the chain seldom reaches the working parts and only succeeds in catching dirt and grit. For the best results, periodic cleaning should be undertaken; the chain should be completely removed and washed in kerosene. After cleaning, soak the chain in a light oil to restore the lubricating film . . . SAE 30 oil should be used. Then remove the excess oil by hanging the chains up to dry. Sprockets, of course, should be cleaned also.

For drives running at medium speeds, **continuous** lubrication is necessary. Drives operating under dusty or dirty conditions should be properly enclosed; in clean locations, a channel surrounding the drive is ample.

Drip sight feed oilers have proved adequate for lubricating medium speed drives. The drops of oil should be directed to the inside of the chain between the side plates as it is entering the drive sprocket. In this way the oil will work into the pins and the bushings. The oil must be drained off periodically, do not allow it to build up in the case. SAE 20 or 30 oil can be used for this class of drive.

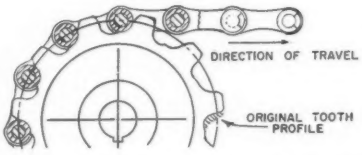


Fig. 4. If sprockets are not too badly worn they can be reversed on the shaft and the opposite surface of the tooth brought into use. Do not try to rebuild a worn sprocket tooth except in cases of extreme emergency

Chains operating at high speeds should be enclosed in an oil-tight case and lubricated with SAE 10 or 20 oil at room temperature. It is important that correct oil level be maintained with the lower strand of the chain just dipping into the oil when the chain is running. If too much oil is placed in the case churning and heating will result. Every few months the quality of the oil should be checked. When extremely high speed drives are under consideration the proper recommendation is SAE 10 oil at room temperature or SAE 20 oil above room temperature.

Chains running at these speeds require a force feed circulating pump system for proper lubrication. Sometimes an external oil cooler is required if the drive is operating in a very warm location.

Periodic inspection routine should be set up and adhered to religiously. Make sure that the chain is in proper adjustment and not excessively slack. If the chain can be lifted perceptibly from the teeth of the larger sprocket —or if a drive running without a case shows daylight between the sprocket and chain—then the chain should immediately be replaced or repaired.

Such a phenomena often shows that the chain has elongated in pitch and no amount of tension adjustment will keep it properly meshed with the sprocket teeth. Continued operation may destroy the sprocket teeth which otherwise are good for a long period of operation.

Out-of-pitch sprockets in a few hours time cause chain wear equal to years of normal operation. It is

Table I. From the table of symptoms listed below it is often possible to determine causes and remedies of ailing drives

SYMPTOMS	POSSIBLE CAUSES	REMEDIES
Excessive noise	Misalinement	Check alinement and correct
	Too little or too much slack	Adjust centers for proper chain slack
	None or improper lubrication	Lubricate—follow instructions
	Loose casing or bearings	Draw up all bolts and brace casings if necessary
	Chain or sprockets worn	Reverse* or renew if necessary
Wear on chain side-bars and sides of teeth	Misalinement	Remove chain and correct alinement
Chain climbs sprockets	Poorly fitting sprockets	Turn chain* and sprockets over and replace if necessary
	Severe overloads	Reduce load if possible—lubricate driven machine
Broken pins and rollers	Chain speed too high for the pitch	Use chain of shorter pitch of equivalent or greater strength
	Shock or suddenly applied loads	Avoid—easy starts give long life
Chain clings to sprockets	Incorrect or worn sprockets	Turn sprockets and chain* over and replace if necessary
	Heavy and tacky lubricants	Clean chain and sprockets and lubricate correctly
Chain whip	Long centers or high pulsating loads	Reduce centers when possible
Chain gets stiff	Misalinement	Check alinement and correct
	Improper lubrication	Remove chain, clean, and lubricate
	Excessive overloads	Reduce load when possible
Broken sprocket teeth	Obstruction—or foreign material in chain case	Check chain clearances Drain and clean chain case
Cotters come out	Vibration and centrifugal force	Turn chains over so heads of cotters are on side nearest shafts

*Applies to cast or steel chain without rollers only.

much more economical always to replace the sprockets when making chain belt replacement. Frequently, additional life may be secured from some types of chain belts by turning them over. In doing this it must be remembered that offset side bar drive chains should generally be run so that the closed end of the link travels forward. In this direction the joint does not flex under full load and less wear occurs on the pins and bushing than when they are run in the opposite direction.

As an emergency measure sprockets that are not too badly worn can be reversed on the shaft and the opposite surface of the tooth brought into use. Only in the event of extreme necessity should attempts be made to rebuild a worn sprocket tooth.

Proper rebuilding of sprocket teeth is an exceedingly difficult job to execute properly, and the original contours are very hard to reproduce. Dismantling chains and substituting new parts should be undertaken only in emergency cases. Most chains are assembled on special machines and their life depends, to a great extent, on the quality of the press-fits. These fits are partially destroyed in dismantling and reassembling chains. In joining chain belts together avoid heavy hammer blows as they tend to distort links and destroy alinement of working surfaces.

Underchaining can materially reduce the life expectancy of a chain drive. A drive which is overloaded 100 per cent has about one-fourth the life of a properly selected drive, according to one manufacturer. Even small overloads can reduce drive life. Be sure they are liberally proportioned.

A handy check list which will enable the engineer or maintenance man to determine, from symptoms, what is causing disturbances in the chain drive and also to apply the proper remedy was made up by The Chain Belt Co. It is reproduced on the preceding page.

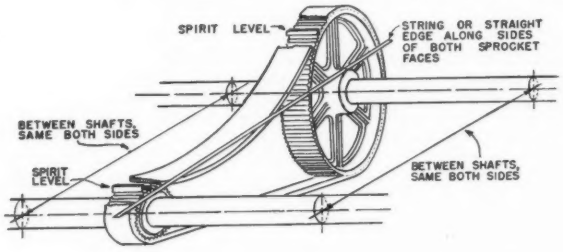

SPIRIT LEVEL
STRING OR STRAIGHT EDGE ALONG SIDES OF BOTH SPROCKET FACES
BETWEEN SHAFTS, SAME BOTH SIDES
SPIRIT LEVEL
BETWEEN SHAFTS, SAME BOTH SIDES

Fig. 5. This shows one method of paralleling and alining shafts and sprockets

Figs. 2, 3 and 4 courtesy, The Chain Belt Co. Figs. 1 and 5 courtesy, Morse Chain Co.

Stepless Speed Variations with Fluid Drives

Systems available to industry . . . Speed control methods . . . Characteristics of systems . . . Typical applications . . . Operating care needed to perform efficiently

AMONG the devices used in industry to adjust the speed ratio between the driving and driven shafts so as to fit the needs of the driven machine, one of the most modern and satisfactory is the fluid drive unit which is available in several different commercial designs. The basic characteristic of all these units is that there is no mechanical connection between the driving and driven shafts. The fluid ordinarily used is oil which is practically incompressible so these drives may rightly be classified as positive, although with controls that are now available the action is not so rigid as to cause shocks when loads are suddenly increased or decreased.

In one system, commonly called hydrostatic, the drive shaft runs a piston pump which creates a pressure in an oil passage leading to a fluid motor attached to the driven shaft.

In another system, called hydrokinetic, the transmission of power depends upon the quantity and velocity of the liquid discharged by an impeller mounted on the driving shaft, against the vane of a turbine runner mounted on the driven shaft.

In both of these systems, torsional vibration does not exist for the reason that there is no mechanical connection between the driving and driven shafts. Inherent vibration or tremors of the driving unit are thus damped out before reaching the driven machine. In this hydrostatic system, any excess of pressure due to overloading automatically bypasses the fluid while in the hydrokinetic system, slip is automatically increased. Heavy load starting from a constant torque source is possible with either system and both provide a high factor of safety against breakdown due to sudden overloading. Both systems may be adapted for use as variable speed drives, the hydrokinetic system being preferred by many in high-speed, high-power operation and the hydrostatic system for large ratio of speed reduction, both, however, within the limits of their speed ratios will permit infinitely small or stepless speed variations.

Variation in speed ratio between the driving and driven shifts of hydrostatic drive units is accomplished by the employment of a variable displacement fluid motor or a volumetric variable displacement pump or both.

Hydrokinetic systems, of which there are two distinct types in common use, are the torque converter and the fluid coupling. They depend upon the amount of liquid contained in the pockets of the impeller and runner and the force with which it is driven. So the method of speed control is to provide some means, such

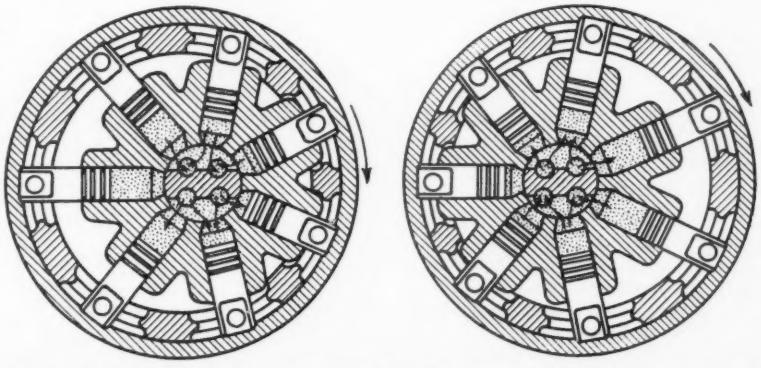


Fig. 1. Cross-sectional diagram of radial-piston pump employed in one type of hydrostatic fluid drive which gives variable volume output

as a pump, for draining off and replacing fluid into the circulating system.

Fundamentally the difference between these two types is that the torque converter has a stationary guide wheel or reaction member placed between the impeller and the runner while the fluid coupling eliminates this guide wheel entirely. This difference in detail gives very different characteristics to these types of drives. The torque converter is usually a means of obtaining higher torque at lower speed of the output shaft. The value of the output torque of the converter is determined by the shape of the blades, the quantity of the circulating liquid, and the driving shaft speed. With fluid couplings, however, the output torque is always exactly the same as the input torque, the speed of the output shaft varying from about 20 per cent to 98 per cent of the speed of the input shaft.

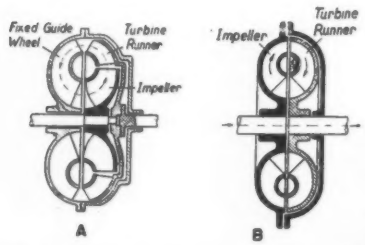


Fig. 2. Diagram showing principles of hydrokinetic systems of fluid drives: A, torque converter with stationary guide vane; B, fluid coupling which has no guide vane

Fluid drives are applicable to such uses as driving lathes, boring bars, foundry cranes, hoists, testing machinery, conveyors, assembly belts, fans, blowers, excavating machinery, looms, paper machinery, and almost any machinery in industry that requires close speed control without jerks or vibration.

In capacity, hydraulic drive units are available in nearly all sizes from ½ hp up to that necessary for driving almost any machine used in industry taking power from electric motors, internal-combustion engines, steam engines, steam turbines or hydraulic turbines.

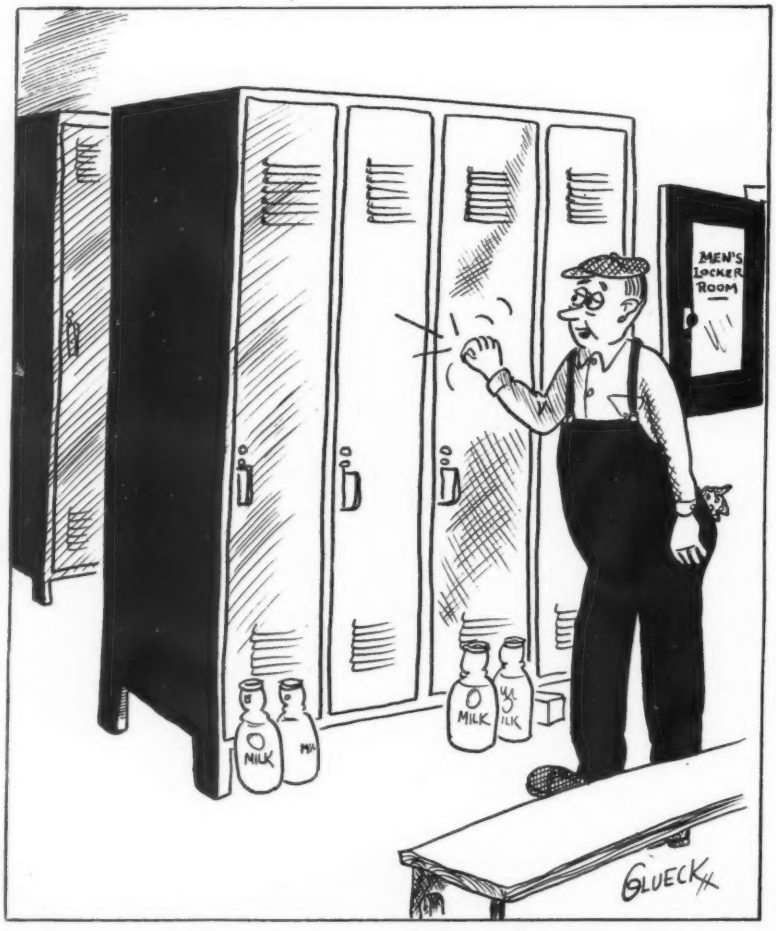
Operating attention required by these units consists principally in observing speed ratios and maintaining shaft alignment. The oil used as the driving fluid also serves as lubricant for the bearings and pump cylinders and the quantity in the sytem should be checked each day or shift. Annual inspection to check for worn bearings and other parts, and for correct clearance spaces should be made a matter of routine practice, and dirt accumulation on internal parts and in oil passages can be observed and corrected at the same time the inspection takes place.

Adjusting Power Drive Speed to Load Requirements

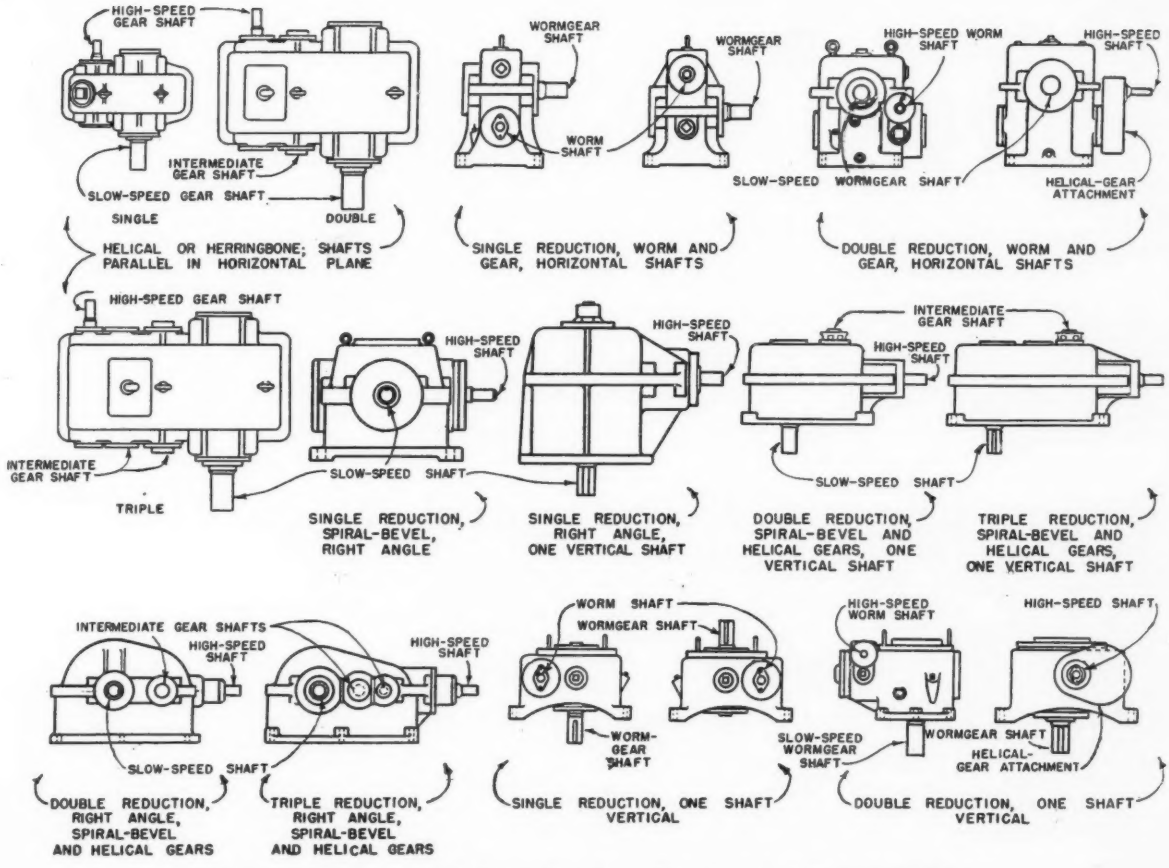
Turbines and motors are run most economically at high speeds and, to apply them to many types of machinery, speed reducing devices have been developed. The gear type speed reducer offers many advantages in variety of applications, range of speed reduction, horsepower capacity available, and in lowering maintenance costs

WHEN high-speed motors and steam turbines came into industrial use, one of their principal advantages was as direct drives for machinery through speed reducing gear units. Motor and turbine speeds as high as 3600 rpm are common in industry and speed reductions as high as 500 to 1 are sometimes required. For speed ratios greater than 12 to 1, gear speed reducer units are usually employed.

Any one or more of the following four types of gears may be employed in the construction of speed reducing units: worm, spur, bevel and herringbone. These gears are enclosed in an oil tight housing which supports the bearings, and the extending shafts are connected by couplings, prefer-



"Hi Joe, It's Time to Wake Up!"



Gear Speed reducers employing various types of gears and shaft arrangements

ably of the flexible type, to the driving shaft of the motor and the driven shaft of the machine.

Horsepower ratings of these units range from fractional to as high as 2800, depending upon the design, type of gears, materials used and speed reductions. Efficiencies vary with design, construction and manufacturing workmanship, generally the greater the speed change the less the efficiency, the range at rated capacities being from 94 to 98 per cent for modern units which employ ball or roller bearings and have the entire gear elements enclosed in an oil tight casing.

Gear speed reducing units are obtainable with shafts in line, shafts parallel but offset, shafts at right angles in any direction, or shafts at offset right angles.

Worm gears have the advantage of a high ratio of speed reduction, from 4 to 1 with single reduction to 6400 to 1 with double reduction. They are essentially right-angle offset drives but can readily be designed for offset parallel shafts by the use of bevel gears. Each additional gear wheel, however, cuts down the efficiency. Worm gears are seldom used as speed increasers.

Spur gear units can be constructed in either the planetary or non-planetary arrangement with the high and low speed shafts in a straight line, in parallel offset positions, or, by the addition of a bevel gear an angle drive may be constructed. They are built for speed reductions from 1 to 1 up to 300 to 1.

Gears of the herringbone type are high in efficiency, silent in operation and applicable to the transmission of large powers. Single reduction gears of this type do not possess the shaft in line features of the spur gear nor the right-angle drive of the worm gear. The gear ratio limits with the various designs range from 1.7 to 1 up to 300 to 1.

In recent years, manufacturers have developed power units known as gearmotors which consist essentially of an electric motor to which is attached a gear speed-reducing element, all combined into one unit, the speed of the power takeoff shaft being that required by the machine it drives, thus eliminating other speed adjusting auxiliaries.

Maintenance work in connection with speed reducers is extremely simple, for the housings of the units are dust proof and oil tight, so that oil changing twice a year is usually found sufficient. The attendant should, of course, observe the conditions of operation daily, particularly for temperatures and vibration and report any undesirable conditions.

RADIANT HEATING is being used to an increasing extent, both in tall buildings and one floor basementless structures. It is also used for outdoor sidewalks for the purpose of snow removal. The most common construction is to imbed prefabricated piping elements in concrete slabs or in the case of one story basementless structures, to locate the pipe on a bed of crushed rock and cover with concrete. Warm water circulated through the pipes heats the concrete to a temperature of about 85 degrees. Cold damp floors are eliminated, heat is distributed evenly throughout the room, and other such solid objects are heated, thus making them in effect auxiliary heating elements. There are no exposed heating devices, equipment can be arranged for the maximum utilization of space, and dust and dirt particles which have a tendency to cling to surfaces and cold walls are eliminated.

How to Make Bearings Last Longer

By H. O. SMITH,
Secretary, Anti-Friction Bearing Manufacturers' Assn.

The Don't and Do's of proper bearing maintenance . . . Three musts in the list of things to do are to keep them dry, keep them covered and keep them clean . . . Directions show that tools to use and how to use them right . . . It's a lot of little things that make the difference between a well-kept bearing and one with a short, useless life

Fig. 1. This is a terrible example but it makes the point—don't work in dirty surrounding; don't use wooden mallets or dirty, brittle or chipped tools

Fig. 2. This is an ideal situation, possible to attain when you start work and almost impossible to keep up unless you exert a lot of effort and work. Remove all the outside dirt from the bearings before you start work and make sure your hands are clean and dry. Lay the bearings out on a clean paper

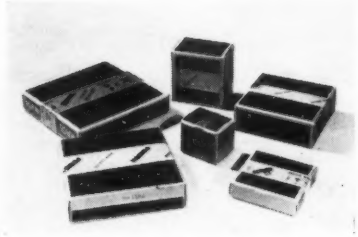


Fig. 3. Keep the bearings in their original boxes. Before wrapping and packing, bearings are carefully cleaned by the manufacturer and are thoroughly coated with a protective lubricant. They are wrapped in grease-proof paper. If a package is removed from the box and not used it should be protected by rewrapping

Fig. 4. Never wash the grease off new bearings. It has been carefully selected by the manufacturer and put there for the protection of the bearing

Fig. 5. Below: Handle the bearings with clean hands; use a clean rag, too

Fig. 6. Never spin bearings when they are dirty as the dirt can cause serious scratches. A short, clean brush with well set bristles is of help in removing dirt, scale or other foreign matter

Fig. 7. When cleaning bearings first soak them thoroughly in plenty of solvent. Let the bearings soak long enough to loosen the grease and dirt. This may take several hours or longer

Fig. 8. After removing them from the solvent rinse the bearings in a container of clean solvent, light oil or kerosene. Make sure no matter what the cleaning agent, that it is CLEAN

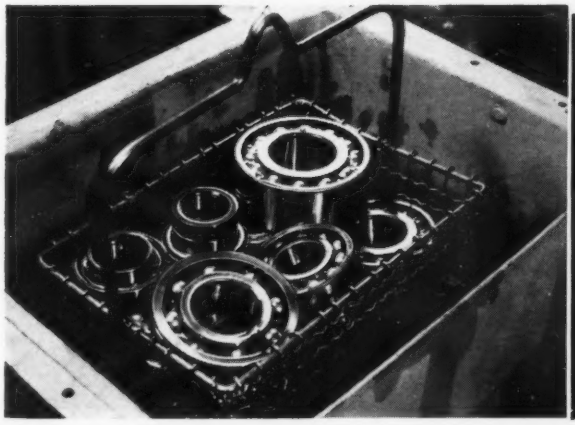
Cleaning and Lubrication

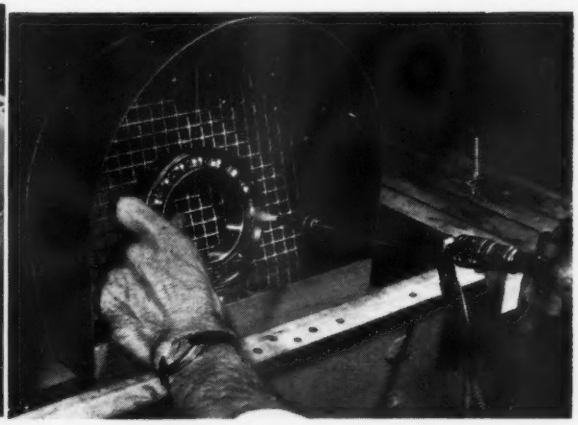
This is the first of two articles on the subject of anti-friction bearings; the second part will deal with the use of tools when working on bearings. Always remember when working with bearings that they actually are finely made instruments fabricated to a high degree of accuracy; don't be careless with them. Every piece of equipment is supplied with a lubrication chart which specifies the kind of grease or oil to be used, how often and how much. Store grease in clean containers and handle it only with paddles or grease guns; keep the grease containers covered. Don't let any machine stand around for months without turning it over once in a while so that all surfaces of the bearings will be covered with lubricant. Oil tends to drain down off a standing bearing and moisture may condense in the housing and cause corrosion. Inspect seals and vents regularly

Fig. 9. It's all right to do this but don't let the force of the air spin the bearing. Hold both rings with your fingers and be certain that air and fingers are clean and dry

Fig. 11. An oil spray cleaner is a desirable and efficient piece of equipment. Use it with a filter in the air line. Bearing cleaning solutions are generally kerosene or gasoline but petroleum solvents intended for bearing cleaning are preferred. Be careful of gasoline containing ethyl or other anti-knock compounds, which are poisonous when absorbed in cuts or when inhaled. All of these solvents are highly inflammable and care should be taken to prevent fires. Use only in a well ventilated room

Fig. 10. A wire basket, if available, is better than a pail. Put in only one layer of bearings and keep the basket off bottom of tank. Bearings with a seal or shield on one side only should be washed, inspected and handled in the same manner as bearings without shields. When seals are removable handle bearings in the same manner as those without shields. Bearings with shields or seals on both sides should not be washed. Just wipe them off to keep the dirt from working inside and scoring bearings





Solving Problems of Vibration Control

Vibration isolation is now a practical, economical necessity . . . Among advantages derived from correctly-designed control are increased machine output, reduced work spoilage, reduced construction costs . . . reduced maintenance costs . . . More efficient plant layout and improved worker health also benefits . . . Case studies covered in this two-part article

By R. L. BOOTH, *Chief Engineer* and
DONALD H. VANCE, *Executive Engineer, The Korfund Co., Inc.**

VIBRATION transmission was once considered a necessary evil inherent in the operation of most machines, but advancement of the theory of vibration isolation and development of cork, rubber and steel-spring vibration isolators have now made possible better operation of all types of machines without vibration transmission.

As a result of experience and development originating from scientific application to thousands of machines, vibration isolation is now a practical, economical necessity as indicated by the fact that consulting engineers, after studying all the economic and

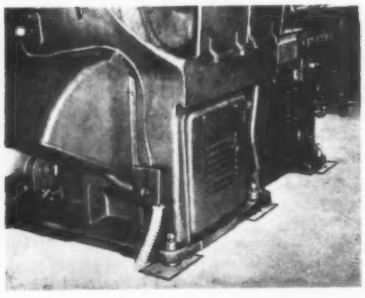


Fig. 1. External vibration which may result in inaccurate work is isolated from this precision grinder

engineering aspects of a proposed installation, are specifying vibration isolation for more and more installations. The owner of a machine whose operation creates vibration can now expect the following benefits from efficient, correctly-engineered vibration control: 1. Increased machine output; 2. Reduced work spoilage; 3. Reduced building and foundation construction costs; 4. Reduced maintenance costs; 5. More efficient plant lay-out; 6. Improved worker safety and health.

Increased output frequently results when it is possible to increase the operating speed of an isolated machine without the danger of vibration transmission to the building and other nearby machines. There have been cases where horizontal reciprocating compressors could not be brought up to maximum speed when mounted on unisolated foundations because of extremely severe vibration set up in the building. The use of an isolated foundation makes it possible to operate any machine at the maximum speed recommended by the manufacturer without danger of vibration transmission.

Furthermore, based upon tests which have been made, some foundation authorities estimate that as much as 10 per cent of the energy delivered to a machine is expended in vibrating the machine foundation, the soil around the foundation and the building. The writers have encountered cases where this transmitted vibration was severe enough to be felt ½ mile away from the vibrating machine. This waste of machine energy can be greatly reduced by the use of properly-engineered vibration control for preventing transmission of forces from the machine foundation.

Thousands of dollars are spent to produce extreme accuracy in such machines as surface and cylindrical grinders, jig borers and other precision equipment. Yet many plant engineers have seen the work of these machines ruined because external vibration jarred the machine and produced flaws in the work. An extremely expensive example of this waste is often encountered in the precision grinding of the hardened steel rolls for paper mills where external vibration frequently ruins the surface on a roll which may be 20 ft. long and 4 ft. in diameter, unless the roll grinder is mounted on an isolated foundation. Isolation against external vibration for precision machinery is being widely adopted, and Fig. 1 shows one such installation under a precision grinder.

"Chattering"—vibration of the machine itself—frequently produces work spoilage on the vibrating machine, or, if the machine is un-isolated, this vibration may be transmitted to

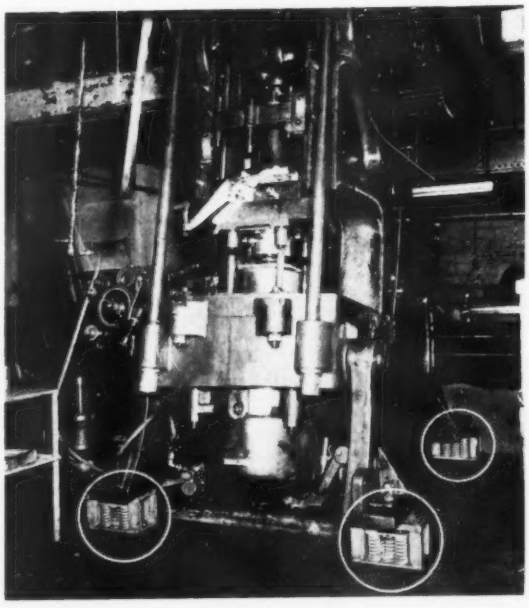


Fig. 2. Even large punch presses, when properly isolated, will not transmit vibration to the floor

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other machinery where it destroys the accuracy of the operation of these machines. Here again, properly designed vibration isolation provides the solution to this problem.

Worker fatigue resulting from continuous subjection to vibration and shock from impact machinery is another important factor contributing to work spoilage. Nerves and muscles become tired under the strain of repeated vibration and it is impossible for the worker to continue doing accurate, efficient work. An example of this has been found with many punch press and hammer operators who have to rapidly and accurately insert material in the dies before each blow is struck. At the end of the day, work spoilage has increased considerably because the workers' coordination has been impaired by vibration fatigue.

Vibration isolation for machinery may save many times the cost of the

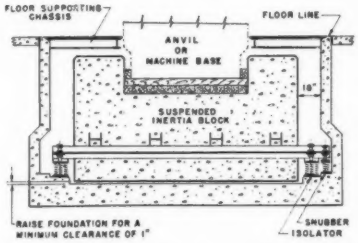


Fig. 3. An installation similar to this resulted in large savings for an automotive parts manufacturer

isolators in building construction costs alone. For example, tests and experience have shown that when even large punch presses are properly isolated as shown in Fig. 2 there is no shock transmission to the floor, and consequently the floor must support only the static load of the machine. When designing a new building, tremendous savings can be made through the use of lighter construction, and vibrating machinery can be safely located in existing buildings where the floor strength would not be sufficient if it were necessary to provide for shock loads.

A very interesting example of savings made possible by efficient vibration control recently occurred at the plant of a large Mid-Western manufacturer of airplane and automotive parts. This company found that the vibration from its forging hammers was seriously affecting the accuracy of precision machines. Plans had been drawn up for an expensive new forge building in order to move the hammers away from the other equipment. Before going to the expense of new construction, it was decided to first try mounting one of the hammers on a spring isolated concrete foundation in the old building. A foundation arrangement similar to that shown in Fig. 3 was used and the results were so excellent that it was impossible to detect any transmitted vibration even with a sensitive vibrometer placed beside the spring isolated foundation. This made it possible to abandon

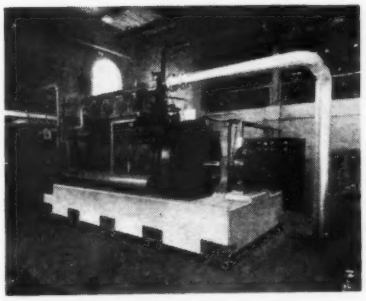


Fig. 4. A spring-isolated foundation similar to this one saved a Cuban building from being wrecked by transmitted vibration

plans for the new building and five hammers have already been installed on isolated foundations with four more underway.

It is also frequently possible to effect savings by reducing the customary machine foundation size. For example, it is unnecessary to increase the mass of an *isolated* foundation because bad soil factors are encountered since the installation can be pre-designed so that there will be no vibration transmission from the foundation into the soil. Another example is often encountered in engine foundations where it is frequently found that the size of the foundation can be reduced by 25 per cent or more when vibration isolation is incorporated. This is particularly beneficial where space limitations prevail or where a larger foundation entails excavation into bedrock, etc.

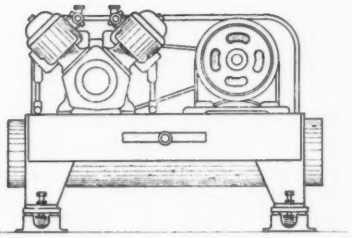


Fig. 5. Typical arrangement of a small high-speed reciprocating compressor-condenser unit on spring isolators

One of the most outstanding advantages of properly-engineered vibration control is the tremendous reduction in maintenance cost which results from elimination of vibration transmission. The writers are familiar with many cases where machine vibration was actually destroying the building. One interesting case occurred in Havana, Cuba, where the frequency of the transmitted vibration from a large engine coincided with the natural frequency of a building wall across the street. Resonance vibration was set up in this wall and it cracked as the result. A properly designed spring isolated foundation such as one shown in Fig. 4 provided a highly satisfactory solution to this problem.

Another interesting example occurred just recently when vibration from a compressor traveled down

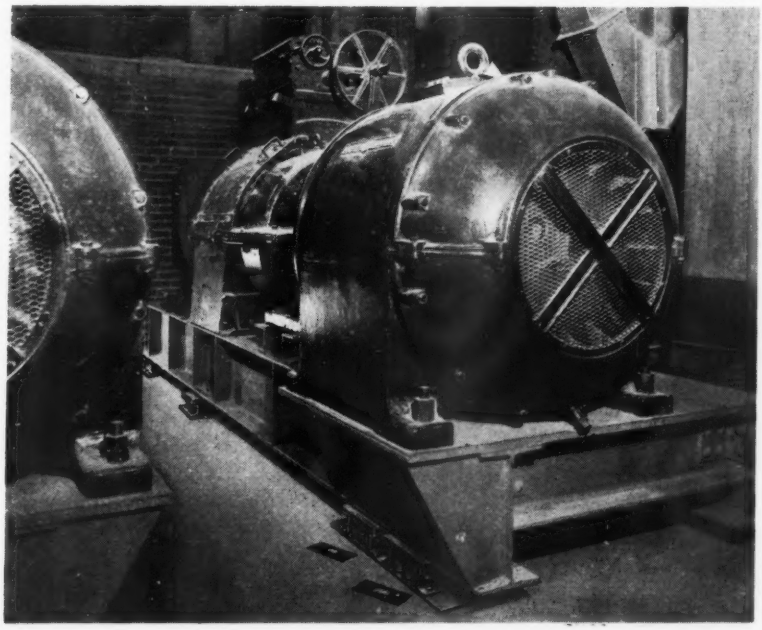


Fig. 6. These hammer mills repeatedly ripped off their foundation bolts until they were mounted resiliently

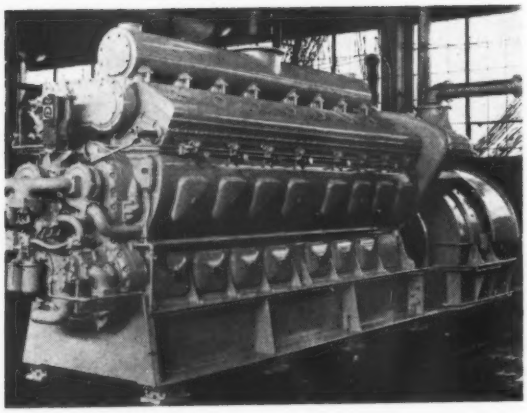


Fig. 7—Left. Here is a typical high-speed engine-generator set which is resiliently mounted

Fig. 8—Right. It was necessary to isolate these drop hammers because of the nearness of precision finishing machines

through the building to a restaurant five floors below. The frequency of this vibration coincided with the natural frequency of large chandelier over a table in the restaurant. This resonance vibration produced in the chandelier was of extreme magnitude and caused it to fall. Further danger of vibration transmission was completely eliminated by the use of an arrangement similar to Fig. 5.

Vibration from one machine may be highly destructive to another machine. For example, the offices of a large company employing forging hammers are located very close to these hammers. The shock from the hammers completely upset the accuracy of the tabulating machines and necessitated frequent repairs until the machines were isolated against this vibration. Figure 6 shows two hammer mills which repeatedly ripped off their foundation bolts and transmitted extreme vibration before being mounted resiliently as shown. Another example of machine vibration destructive to itself was encountered by one of the writers on a number of engine-generator installations for the U. S. Navy. Due to stresses set up in the engine base by vibration, the castings cracked as fast as they were welded. Resiliently mounting these generator sets relieved the stresses and prevented further failures. A typical high-speed engine-generator installation is shown in Fig. 7.

At the outset of the war it was imperative that mass production on an "assembly line" be established in the aircraft industry. This presented tremendous difficulties because drop hammers could not usually be located close to precision finishing machines due to the vibration created. Mounting the hammers on spring isolated foundations made it possible to adopt efficient plant layout as shown in Fig. 8 and to locate the hammers right in the production line beside the most sensitive equipment, without difficulty.

An interesting example occurred on several occasions where it was found that one aircraft plant had a surplus of hammers whereas another had a serious shortage. *The hammer and its foundation* with the isolators attached were lifted out of the pit at one plant, placed on a flat car and shipped to the second plant for immediate installation and renewed production. Figure 9 shows one of the foundation blocks being lowered into position.

The forging industry has always had difficulty with vibration from hammers loosening the firebrick in the arches of the forging furnaces and causing bricks to fall. Rebuilding the furnaces, an expensive proposition, has been entirely eliminated by the arrangement shown in Fig. 10 where it will be noted that a forging hammer and a forging furnace are located side by side without vibration transmission from the hammer to the furnace.

In chemical processing plants, it is frequently desirable to locate separators, pulverizers, and other types of vibrating machinery high in the building in order to permit a "gravity flow" of the material down from one floor to another of the plant. This frequently entails installation of the equipment on steel beams or on platforms far above the floor where it is quite difficult to design a structure rugged enough to withstand vibration transmission. Here again, vibration isolation permits this procedure.

With properly designed vibration control available for all types of ma-

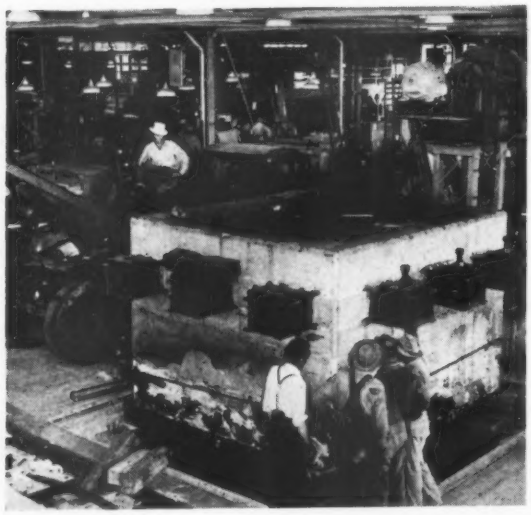
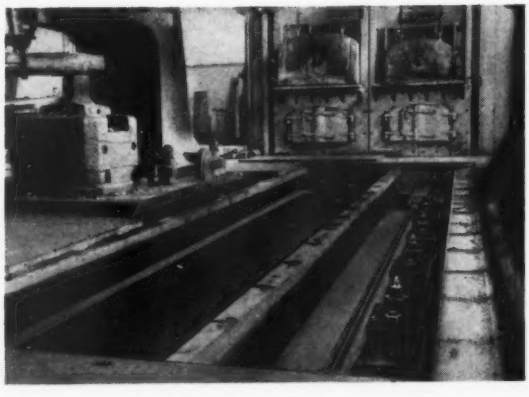


Fig. 9—Left. Hammer foundation blocks are being lowered into place with the isolators installed

Fig. 10—Below. Firebrick in the arches of the furnaces in the background was continually being shaken loose until hammer foundations were isolated



chinery, the plant engineer can locate his equipment wherever he chooses for maximum production efficiency without vibration from one machine interfering with operation of another.

Efficient vibration control can produce savings through reduction in worker absenteeism and accidents. Uncontrolled vibration produces a very definite strain upon employe's nerves and results in fatigue which frequently leads to accidents. The type of severe shock associated with punch press, hammer and other impact machinery operation is particularly injurious to workers' kidneys, and after these machines are resiliently mounted to prevent vibration transmission, rapid improvement in the operators' health generally results. Naturally it is also impossible for office employees to work and maintain a healthy mental attitude when subjected to the annoyance of vibration transmitted through the building structure from machinery to the offices.

Sems—What Are They?

By WALTER M. HANNEMAN, Chief Engineer, Illinois Tool Works

THE USE of lock washers as a means of locking screws has long been accepted and found satisfactory for applications where security of fastening is of primary importance. For years the accepted practice was to have the operator, when assembling an article, place a loose washer on the screw before driving it home. This procedure has been simplified by combining the screws and washers into single fastening units prior to their use. These new fasteners are now commonly known as sems.

Sems are screw and washer assemblies wherein the washers are held beneath the screw heads by rolled threads and are free to rotate. In the manufacture of sems, screw blanks which have shank diameters approximately equal to the screw pitch diameters, are selected from a hopper and fed down an inclined chute. Lock washers, with holes slightly larger than the shank diameters, are selected in another hopper and transported one at a time to the point of assembly. The blanks and washers are then assembled, progress down a chute, pass between thread rolling dies and emerge as sems. The increased thread diameter traps the washer between the screw head and threads.

Standard spring and tooth lock washer sems have been designed for each standard head and size of screw up to and including ⅜ in. diameter. A variety of designs is available for applications requiring special diameters, or designs, of lock washers or where special screw heads are desired. Some sems are being manufactured where a second piece, such as a terminal clamp or a flat washer is added in addition to the lock washer.

The minimum possible outside diameters of tooth lock washers are closely related to the hole diameters. Since the holes of the lock washers on sems are smaller than those of loose lock washers, it is possible to keep the washer diameters in closer relation to the screw head diameters. Not only is appearance improved by the washer being confined under the head instead of projecting beyond, but better locking efficiency results from more locking tooth contact between screw head and washer.

Where internal tooth lock washers are used, the teeth extend inwardly to the blank diameter and keep it from falling off the screw. This permits longer teeth in contact with the screw head, resulting in increased locking efficiency.

Where spring lock washers are desired, wider and heavier cross sections may be used. This in turn, of course, results in stronger spring reaction as well as increased thrust bearing area of contact between screw head and washer.

Upon first consideration, the idea prevails that the maximum benefit for the use of sems, as a substitution for screws and loose lock washers, lies in the time saved in assembling the two parts. While this saving of labor is an important item, especially where large quantities are used, it is by no means the principal advantage to be gained by their use. The possibility of maintaining closer relation between washer and screw head diameters results in a better application both in locking efficiency and appearance. Instead of a single diameter standard spring or tooth type lock washer for each size of screw, as is customary when loose washers are used, there are now available several diameters of lock washers for each size screw. This permits selection of washer diameters in relation to head diameters, and the proper washers are always supplied attached to the screws when sems are used. Sems also eliminate the possibility of using lock washers in the wrong places or using the wrong washer. The eccentricity of lock washer to screw head is also considerably less on sems.

The purchasing department benefits by having only one source of supply instead of two, thereby decreasing its work connected with requisitions, purchase orders, follow up and accounting. The planning and production control departments have their work halved, and there is also an automatic balance between the two related parts. They also are guarded against depletion of lock washer stock due to misapplications or applications not specified.

Loss of lock washers due to falling on the floor and being swept up is eliminated and shrinkage is therefore materially reduced.

The inspection department is assured that a lock washer of the proper size is applied where the design calls for it. The temptation of assemblers "short cutting" by leaving off lock washers is removed.

The saving of labor through the use of sems is of utmost importance, particularly where large quantities are applied with power drivers. Automatic screw driving machines handle sems very efficiently. Where hand power drivers are employed the operator can pick up the sems with his free hand. There is no need for laying the driver aside to free both hands to permit applying the washer to the screw before insertion. This materially increases the speed of assembly.

Sems are now being specified for nearly every type of article assembled with screws. Where the security of the screw is of paramount interest, sems are ideal. Parts subject to vibration or expansion and contraction are improved by the use of sems.

Certain applications exist where sems are of utmost importance. Where it is necessary, for instance, to assemble a small spring part with a small short screw and lock washer, difficulties arise, especially where dexterity in the assembler is lacking. This operation is materially simplified by using sems, particularly if they are of recessed head design. Recessed head sems, which can be supported on the end of the screw driver, also are of considerable value where the screw and washer must be driven in difficult or hard to reach locations such as in back of cabinet. This holds true also, where narrow channels are used in assembly.

One of the greatest economies resulting from the use of sems lies in the factor of "overhead burden" or "non-productive costs." In analyzing the cost of an operation, concentration is usually on the observable or direct labor costs. However, in many plants, the overhead burden is often 100, 200 or even 300 per cent of the direct labor cost. When this factor is considered, such direct labor costs as seem of small significance assume proportions which make them well worthy of fullest consideration. *From "Fasteners."*

How to Keep Steam Traps at Peak Efficiency

If right trap for each application were properly installed in the first place, there would be little need for trap inspection and maintenance . . . Since this has not always been done, we must take the traps as we find them . . . They have two types of trouble —1, sometimes they don't drain condensate; 2, sometimes they blow live steam . . . Regular inspection schedule will reveal causes of trouble . . . What to look for in inspecting . . . Regular maintenance program will cut maintenance costs . . . Details of maintenance . . . Correct piping, pressures, strainers are described

A STEAM TRAP is an automatic valve used in draining condensate from steam-heated units. It does not itself drain the condensate but functions either intermittently or continuously to allow the steam pressure to push out condensate and/or air for further disposal. Pumping or return traps are not treated here; the following refers only to non-return or separating traps.

You can reduce maintenance on steam traps in your plant by doing these two things:

1. Make a study of the traps to see if they are of the right type for each particular service; if they are properly piped and installed, with proper accessories, such as strainers, ahead of the traps; if the steam pressure ahead of the trap is right; if the trap has automatic air vent where required; and so on. If the right trap for the job is installed correctly in the first place, there should be no need for much trap maintenance. Of course, traps sometimes give trouble like all other equipment but, when traps are properly applied and installed, these troubles should be only of a very minor and infrequent nature.

2. Establish a regular trap inspection and maintenance routine in your plant. If you have only a few traps in a relatively small plant, such a routine is simple. But in a plant of any size there may be from 50 to 500 traps and there are many large industrial plants in which 3000 or 4000 steam traps are installed. Thus the inspection and maintenance schedule for these traps becomes quite a program.

If the proper trap is selected in the first place, there may be no need for by-passes or "blowing down" connections, for certain types of traps are wide open when cold—i. e., thermostatic traps—hence may need no bypass. If traps are equipped with air venting devices, air is vented automatically. Air pockets in pipe lines can be equipped with air eliminators. Since most of these conditions are known in advance, a correct trap can be chosen the first time. To repeat, much trap maintenance could be eliminated, condensate drainage and heating-up of steam-using equipment greatly improved, and heating costs lowered, if the right trap were correctly installed.

In many cases, however, this has not been done, hence the need for regular inspection and maintenance programs. Such a maintenance schedule should be laid out so that the maintenance engineer can follow it conveniently and regularly. Often the responsibility for all traps in a plant is given to one maintenance engineer, who may already be a steam trap "specialist" or will soon become one by working on them.

The trap maintenance program in one large industrial plant containing some 4000 traps, has paid dividends. Large charts and colored drawings of all the different types of traps are available to the maintenance engineers for study. Careful attention is first paid to checking type, rating, size, steam pressure, inlet and discharge piping, and other factors, when installing traps. No trap is allowed to serve more than one heating unit. Condensate polluted with any chemical is drained to the sewer. Check valves are installed to prevent process liquids from being sucked back into the steam line and drained through main line traps back into the boiler water circuit.

The following program is in effect in the above plant:

1. Every day—Blow all main line or unit traps ¾ in. or larger by means of telltale connection.

2. Every 6 months — Test traps under ¾ in. or industrial units. Repair—usually buckets and valve seats.

3. Frequently—Check trap returns to make sure no hard water or other impurity is leaking into condensate.

4. Every 5 years—Check and repair low-pressure traps in branches of heat systems.

5. Beginning of each heating season—clean out all dirt pockets in steam lines.

More detailed procedures advocated by many engineers are as follows:

Fig. 1. Joe Spiegle, plant engineer, Eastern Box Co., examining trap draining a steam header

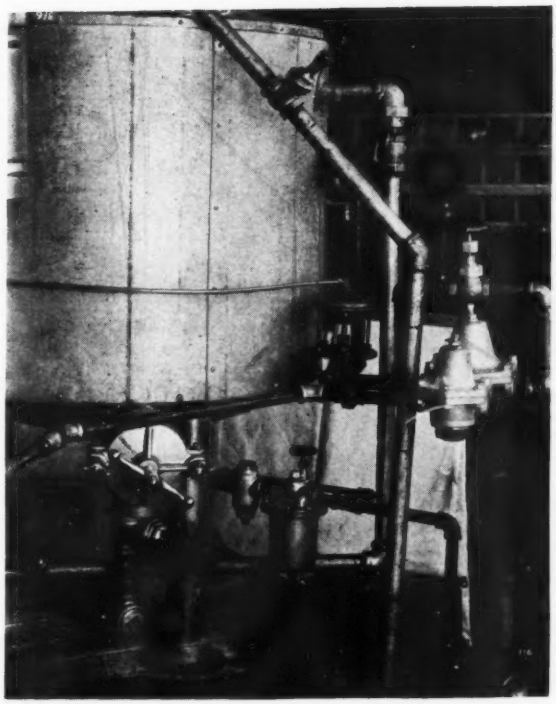


Fig. 2. Trap installed on a process vessel, with strainer ahead of trap and valved by-pass around it

1. **Proper trap location.** Trap should be below drainage point or unit drained, if possible. Accessibility aids maintenance.

2. **Blow out line or machine** at full pressure before installing trap, to remove dirt and pipe thread cuttings that might get into trap.

3. **Install a trap on each steam heated unit.** Old practice of draining two or more spaces by a single trap leads to short circuiting, excess steam consumption by the steam-using machine, higher labor cost.

4. **Size traps properly.** Traps too large may blow through, causing high steam consumption. Traps too small, too much time required in heating up the steam-using apparatus. But trap must be big enough to have starting-up and peak-load capacity, also sufficient air-handling capacity Manufacturers have tables and curves of pipe sizes, trap capacities, and all necessary data for selecting right size trap.

5. **Be sure steam pressures at trap inlet are correct.** If too high, thermostatic elements are damaged, or mechanically-operated traps cannot open their valves against pressure. If too low, heating and process units will not get enough steam, traps may not have enough pressure differential to work right. Check to see if back pressure is higher than inlet pressure.

6. **Keep inlet and discharge piping clean.** Strainer ahead of trap recommended, perforations not larger than 1/64 in. Clean out strainers regularly.

7. **Be sure trap is installed right way.** Some traps have arrow showing correct flow direction.

8. **Check trap discharge** for "steam blow." If trap is passing live steam it will be a heavy and loud blast of clean-looking steam with little condensate in it. If trap is working right, flash steam from condensate is white, "lazy-looking," contains condensate or moisture. Hot condensate will always flash when its pressure is lowered, so learn to tell it from live steam.

9. **Have correct vacuum** in vacuum return lines. See that all parts of thermostatic trap—cover, tail piece, union—are tight against back leakage of air.

10. **Have regular test schedule for traps.** All except radiator traps should be equipped with test valve on downstream side of trap valve. A T or Y with pipe plug can be used in place of test valve. If back pressure in return line is high, put check valve or shut-off valve in discharge line to prevent return line flash steam from passing through test valve.

Routine Inspection

11. **Routine inspection schedule** — At least once a year all traps should be opened for inspection, cleaned thoroughly and repaired if necessary. (Note: Do not open a thermostatic trap while it is hot. To do so may ruin the bellows or diaphragm. Many thermostatic traps are installed on heating systems and their inspection should be done in the summer time.)

a. Is the trap body or mechanism dirty? Remove all sediment and other dirt from the trap body. Mechanisms may require cleaning by immersing in gasoline or kerosene. If there is an exceptional amount of dirt, it might be advisable to install ahead of the trap a strainer, which will have to be blown down or cleaned at periodic intervals. The presence of an oily paste in the trap body, particularly on traps draining lines supplied with exhaust steam from reciprocating engines, may indicate that the engines are getting an excessive amount or poor grade of oil. Check this point.

b. Are valves and seats tight? If the valve seat has a sharp edge and if there is a narrow and shallow bright ring all the way around the valve, the chances are that the valve is making a tight joint with its seat. All valves and seats that have become wire drawn or badly grooved from wear should be replaced with new valve parts that have been properly lapped together. Be sure that the new valve parts are the right size for the trap and the operating pressure.

c. Is the operating mechanism in good condition? Cracked or corroded buckets should be replaced. A closed float that is partly filled with water indicates a leak and the float should be replaced. Worn out and inoperative interiors of thermostatic traps should be replaced.

Check the operating mechanism, or leverage system, for smooth operation. Any erratic action should be eliminated by repairing or replacing worn, corroded, or damaged parts.

d. Is the air-venting mechanism in good condition? If trap buckets are equipped with an auxiliary bi-metal thermostatic air vent, make sure that it is functioning properly by immersing in boiling water.

In float and thermostatic traps check the bellows, valve and seat. Replace worn bellows or worn valve parts.

12. **Keep trap by-pass valves tight.** If traps are installed with a by-pass, it is highly important that the by-pass valve be checked to make sure it is perfectly steam tight. If the trap can be operated without the by-pass, by all means remove it. Avoid the more or less common practice of opening by-pass valves and leaving them open. It wastes a tremendous amount of steam.

13. **Are traps in your heating system passing steam?** Check the temperature of the trap return main and if too high at the pump room or boiler room, trace back along the re-

(Continued on page 65)

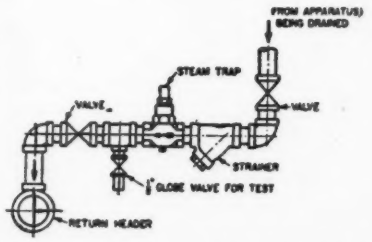


Fig. 3. How test valve is installed with an impulse type trap

To Get Right Pump for the Job— First Find Pipe Friction Losses

By ROY CARTER and I. J. KARASSIK
Application Engineers, Worthington Pump and Machinery Corp.

NUMEROUS pipe friction tables, charts and formulas are available for the determination of friction head losses in pipes, but the blind use of such information is dangerous, for their incorrect use will give fictitious values. It is advisable, therefore, for users of centrifugal pumps to understand the flow of water in pipes so that any frictional head calculations they may make will be reasonably accurate.

Strange as it may seem, the characteristics of the flow of liquid in a pipe varies with the velocity. With very low velocities, viscous flow occurs. Under these conditions, the effect is that of shearing of concentric cylinders of the liquid past each other in an orderly fashion, with greatest velocity at the center of the pipe and zero velocity at the pipe walls. With water, the average velocity at which viscous flow is obtained is very low and, as a result, is rarely to be encountered in normal applications.

AUTHORS' FOREWORD

When purchasing centrifugal pumps, the total head must be specified. As all pumping systems involve some piping, it is essential that the friction head losses be established with sufficient accuracy, so that the proper pump will be obtained for the service. In view of the general lack of understanding of the use of friction tables, the authors have seen the need of an article covering this subject accompanied by tables that would put together the necessary tools so that the friction head losses in systems handling water could be intelligently estimated. This article deals with friction head loss calculations in pipes and will be followed by a second article on the friction head loss calculations for valves and fittings. While the authors desire to point out that this material is not new, they believe it has not been previously presented in an easily usable form.

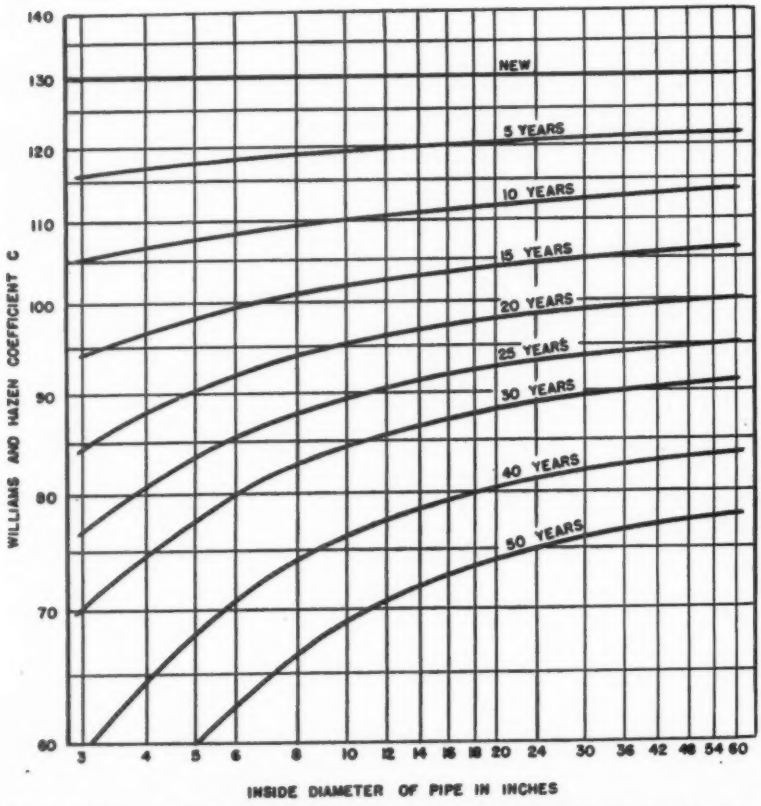


Fig. 1. Change in Williams and Hazen coefficient C with years of service, for cast-iron pipes handling soft, clear unfiltered water

As the average velocity of the liquid is increased the flow becomes no longer orderly. This is called turbulent flow. When turbulent flow exists, the axial velocity measured across the pipe diameter is more uniform than in viscous flow and there is an area adjacent to the pipe walls where the flow is viscous in character. The average velocity at which the flow will change from viscous to turbulent is not definite, as there is a critical range in which the character of the flow may be of either type.

The flow of any liquid is accompanied by friction of two types: internal friction caused by the rubbing of the fluid particles against one another and external friction caused by the rubbing of the fluid particles against the pipe walls or against the static layer of liquid adhering to the walls. Energy must be expended to overcome this friction.

With turbulent flow, the friction is partly dependent upon the roughness of the walls. Since the interior surfaces of pipes of the same material are practically the same irrespective of diameter, small pipes are relatively rougher than larger pipes. Thus, for equal velocities it follows that the larger the pipe, the smaller the friction loss will be.

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Pumping of water by centrifugal pumps for a multitude of uses in industrial plants is one of the problems most common to plant engineers . . . Here is the first of several articles designed to show, in the most practical way and without elaborate mathematical calculations, how to keep pumping costs down by fitting the right pump to each job . . . But before you try to select the right pump, you must find the friction losses . . . Here are simple curves and tables of friction head loss data to help you make an intelligent estimate of these losses in water systems . . . Data given for many kinds of pipe

Numerous pipe friction experiments and studies have been made and a great number of tables and charts have been made. Williams and Hazen's tables was one of these earlier works for water and has been found reliable, particularly for cast-iron pipes of 3 in. or larger diameter. These tables are based on an empiric formula which can be modified to the form:

$$h_f = 10.45\ (Q \div C)^{1.852} \times (L \div d^{4.87})$$

where h_f = loss in head in feet of water for length L
Q = flow in gpm
d = inside diameter of the pipe in inches
C = coefficient of smoothness of the pipe
L = length of the pipe in feet

The coefficient C is an index of the smoothness of the interior pipe surface (the smoother the pipe interior, the higher the C value) and the selection of the proper value of this coefficient will determine the accuracy of the friction head loss value calculated for any problem. For new unlined cast-iron pipe, a value of C = 130 is usual but some new pipes in which the friction head losses indicate C values of 140 or higher have been encountered. Pipes which are coated on the interior to give a smoother surface naturally will have a higher C value. There are also records of pipes made of rolled metal and of very smooth cement which have C values of 145 to 150 or higher.

Most pipes in use deteriorate with age and thus the C value becomes less. This decrease in C value, or increase in friction head loss, is dependent upon the material of the pipe, upon the pipe coating used, if any, and upon the character of the water. Therefore it is a guessing game to select a C value for an old pipe. Thus, when it is necessary to make studies involving friction head losses in an old pipe, a test should be made, if it is at all possible, to obtain the friction loss at some known capacity so the coefficient can be approximated. When such a test cannot be made, some guide to indicate the average change in the values of C with age is desirable. Such a guide is indicated in Fig. 1 which shows in chart form, coefficients that might be expected for cast-iron pipes handling soft, clear, unfiltered water.

Pipes carrying filtered water, not chemically treated, have been found to deteriorate less rapidly than pipes handling unfiltered water. Chemically treated waters have been found in some cases to produce more corrosion in the pipe than untreated water. Brackish water generally results in increased tuberculation. Some moderately hard waters have been found to cause a slow rate of deterioration. On the other hand, cases have been noted where the water is capable of depositing calcium carbonate on the interior of the pipe thus both reducing its size and increasing the roughness. Smooth cement and cement lined pipes have been found to maintain a high C value for many years.

All these possibilities make it difficult to select, with any assurance of accuracy, the proper coefficient, so any guide like Fig. 1 should be used with reservations. In important studies it is often possible to locate a similar installation and use the head losses obtained as a guide.

When the selection of pumping machinery is involved, it is particularly desirable to consider the friction head loss that may occur when the installation is new, as well as that which may result some years after it has been in service. It has, in a way, been unfortunate that most charts and tables based on the Williams and Hazen formula have been made for a C of 100. As that value is approximately that to be expected for 15-year old pipe, practice has developed to use this as a design value, and no calculation is made of what the friction will likely be when the installation is new. This gives a distorted picture of the problem.

For example, in a new installation where most of the pumping head is friction, the actual friction head would be lower than allowed for in the selection of the pump, with the result that the pump would deliver more capacity at some reduced head which equalled the system head. This excess would be dependent upon the pump characteristics and the increase in system head with capacity, but might be 15 to 25 per cent more than that for which the pump was selected.

Such operation at increased capacity might cause more power to be required by the pump, thus overloading the driver or, if the installation was one in which the available NPSH (net positive suction head) at design capacity exceeded only slightly the NPSH required by the pump for the design capacity, the resulting increase in pump capacity with the lower operating head would result in cavitation occurring in the pump.

Table I showing pipe friction losses for 3 to 24 in. inside diameter pipes based on Williams and Hazen's formula with C of 100 appears on page ... The usual values of C used for new pipe are:

Smooth unlined cast-iron	130
Asphalted cast-iron	140
Cement asbestos	130-140
Very smooth cement or cement lined cast-iron	130-140
Ordinary cement	110-120
Drawn steel or W. I.	130-140
Riveted steel	90-110

For convenience in converting friction values based on C of 100 to other C values, conversion factors are indicated in Fig. 2. For example, 6 in. pipe, the friction head loss is 6.23 ft per 100 ft of pipe with C = 100. For C = 130, the multiplier is 0.613; so, with that C value, the friction head loss will be 6.23 × 0.613 or 3.83 ft per 100 ft of pipe.

For cold water service, steel and

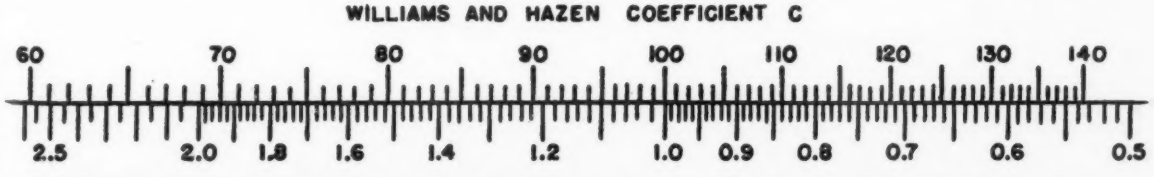


Fig. 2. Scale of conversion factors for converting friction values based on coefficient C = 100 to other C values

wrought-iron pipes are used extensively in sizes up to 8 in. and larger for some services. In drainage and irrigation work, steel pipe is used almost exclusively, with the larger sizes being fabricated of steel plate. Cast-iron pipe is now seldom used for water lines in sizes less than 3 in. Most long water lines are cast-iron, but the cement asbestos type also finds considerable favor. As steel pipe is made with the same outside diameter for a number of different weights or wall thicknesses, the inside diameter will not be the same as the nominal diameter, and the friction losses for a given capacity must be corrected for such differences.

With steel and wrought-iron pipe it is even more difficult than for cast-iron to predict the change in friction head that will result when the pipe becomes older. In some cases, the pipe decreases in area due to tuberculation, while in other cases the pipe corrodes and the film is washed away.

Table I. Velocity and friction head loss in feet of water per 100 ft of pipe, for water in 3 to 24 in. inside diameter pipe, based on Williams and Hazen's formula with C = 100. These friction values are usually considered to apply to cast-iron pipe after 15 years' service handling average water

G.P.M.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	G.P.M.
							3" PIPE		4" PIPE								
30							1.36	.534	.77	.131	5" PIPE						30
40							1.81	.910	1.02	.224							40
50							2.27	1.38	1.28	.338	.82	.114	6" PIPE				50
60							2.72	1.92	1.53	.475	.98	.160					60
70							3.18	2.56	179	.631	1.14	.213	.79	.088			70
80							3.63	3.28	2.04	.808	1.31	.273	.91	.112			80
90							4.08	4.08	2.30	1.01	1.47	.339	1.02	.139			90
100							4.54	4.96	2.55	1.22	1.63	.412	1.14	.170	8" PIPE		100
125							5.68	7.50	3.19	1.85	2.04	.623	1.42	.256			125
150							6.81	10.5	3.83	2.59	2.47	.874	1.70	.360	.96	.089	150
175							7.95	14.0	4.47	3.44	2.86	1.16	1.99	.478	1.12	.118	175
200							9.08	17.9	5.10	4.41	3.27	1.49	2.27	.613	1.28	.151	200
225							10.2	22.3	5.74	5.48	3.68	1.85	2.55	.762	1.44	.188	225
250							11.3	27.1	6.38	6.67	4.08	2.25	2.84	.926	1.60	.228	250
275							12.5	32.3	7.02	7.96	4.50	2.68	3.12	1.11	1.76	.272	275
	12" PIPE																
300							13.6	37.9	7.65	9.34	4.90	3.13	3.41	1.30	1.91	.320	300
350	.99	.059	14" PIPE				15.9	50.4	8.93	12.4	5.72	4.20	3.97	1.73	2.23	.425	350
400	1.13	.076					18.2	64.6	10.2	15.9	6.54	5.38	4.54	2.21	2.55	.545	400
450	1.28	.094	.94	.044					11.5	19.8	7.36	6.68	5.10	2.75	2.87	.678	450
500	1.42	.114	1.04	.054	16" PIPE				12.8	24.1	8.18	8.12	5.68	3.34	3.19	.823	500
550	1.56	.136	1.15	.064					14.0	28.7	8.99	9.69	6.24	3.99	3.51	.982	550
600	1.70	.160	1.25	.076	.96	.039			15.3	33.7	9.81	11.4	6.81	4.68	3.82	1.15	600
650	1.84	.186	1.36	.088	1.04	.046	18" PIPE		16.6	39.1	10.6	13.2	7.38	5.43	4.15	1.34	650
700	1.99	.214	1.46	.100	1.12	.052			17.9	44.9	11.4	15.1	7.94	6.23	4.47	1.53	700
750	2.13	.242	1.56	.114	1.20	.060	.95	.034			12.3	17.2	8.51	7.08	4.78	1.74	750
800	2.27	.273	1.67	.129	1.28	.067	1.01	.038	20" PIPE		13.1	19.4	9.08	7.98	5.10	1.97	800
900	2.55	.339	1.88	.160	1.44	.084	1.13	.047			14.7	24.1	10.2	9.92	5.74	2.44	3.67	.825	900
1,000	2.83	.412	2.08	.195	1.60	.102	1.26	.057	1.02	.034	16.3	29.3	11.4	12.1	6.38	2.97	4.08	1.00	1,000
1,100	3.12	.492	2.29	.232	1.76	.121	1.39	.068	1.12	.041	18.0	35.0	12.5	14.4	7.02	3.55	4.50	1.20	1,100
1,200	3.40	.578	2.50	.273	1.92	.143	1.51	.080	1.23	.048			13.6	16.9	7.66	4.17	4.90	1.41	1,200
1,300	3.69	.671	2.71	.316	2.08	.165	1.64	.093	1.33	.056	24" PIPE		14.8	19.6	8.30	4.83	5.31	1.63	1,300
1,400	3.97	.770	2.92	.363	2.24	.190	1.76	.107	1.43	.064			15.9	22.5	8.93	5.54	5.72	1.87	1,400
1,500	4.25	.875	3.12	.413	2.40	.215	1.89	.121	1.53	.073	1.06	.030	17.0	25.5	9.55	6.30	6.12	2.13	1,500
1,600	4.54	.985	3.33	.465	2.55	.243	2.02	.137	1.63	.082	1.13	.034	18.2	28.8	10.2	7.10	6.53	2.39	1,600
1,800	5.11	1.22	3.75	.578	2.87	.302	2.27	.170	1.84	.102	1.28	.042			11.5	8.83	7.35	2.98	1,800
2,000	5.67	1.49	4.17	.703	3.19	.367	2.52	.207	2.04	.124	1.42	.051			12.8	10.7	8.17	3.62	2,000
2,500	7.09	2.25	5.21	1.06	3.99	.555	3.15	.312	2.55	.187	1.77	.077			16.0	16.2	10.2	5.48	2,500
3,000	8.51	3.16	6.25	1.49	4.78	.778	3.78	.438	3.06	.262	2.13	.108			19.1	22.8	12.3	7.67	3,000
3,500	9.93	4.20	7.29	1.98	5.59	1.04	4.41	.583	3.57	.349	2.48	.143					14.3	10.2	3,500
4,000	11.3	5.38	8.33	2.54	6.39	1.33	5.04	.746	4.08	.447	2.83	.184					16.3	13.1	4,000
4,500	12.8	6.63	9.38	3.15	7.18	1.65	5.67	.928	4.59	.555	3.19	.228					18.4	16.3	4,500
5,000	14.2	8.13	10.4	3.83	7.98	2.00	6.30	1.13	5.10	.675	3.54	.278							5,000
5,500	15.6	9.70	11.5	4.58	8.78	2.39	6.93	1.35	5.61	.806	3.90	.332							5,500
6,000	17.0	11.4	12.5	5.38	9.68	2.81	7.56	1.58	6.12	.947	4.25	.390							6,000
6,500	18.4	13.2	13.6	6.24	10.4	3.26	8.19	1.83	6.73	1.10	4.61	.452							6,500
7,000	19.9	15.2	14.6	7.16	11.2	3.74	8.82	2.11	7.15	1.26	4.96	.518							7,000
7,500			15.6	8.13	12.0	4.24	9.45	2.39	7.66	1.43	5.32	.589							7,500
8,000			16.7	9.16	12.8	4.79	10.1	2.69	8.17	1.61	5.66	.664							8,000
9,000			18.8	11.4	14.4	5.95	11.3	3.39	9.18	2.01	6.38	.825							9,000
10,000					16.0	7.24	12.6	4.07	10.2	2.44	7.09	1.00							10,000
11,000					17.6	8.63	13.9	4.86	11.2	2.91	7.80	1.20							11,000
12,000					19.2	10.1	15.1	5.71	12.3	3.42	8.51	1.41							12,000
13,000							16.4	6.62	13.3	3.96	9.12	1.63							13,000
14,000							17.6	7.59	14.3	4.54	9.93	1.87							14,000
15,000							18.9	8.63	15.3	5.27	10.6	2.13							15,000
16,000									16.3	5.82	11.3	2.40							16,000
18,000									18.4	7.24	12.8	2.98							18,000
20,000											14.2	3.62							20,000
25,000											17.7	5.48							25,000

VEL.—Velocity in feet per second. FRIC.—Friction head loss in feet of water per 100 ft of pipe

Table II. Velocity and friction head loss in feet of water per 100 ft of pipe, for water flowing in new 1-in. to 10-in. nominal size Schedule 40 (standard weight) steel pipe

G.P.M.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	VEL.	FRIC.	G.P.M.
					1" PIPE (1.049" ID)		1¼" PIPE (1.380" ID)		1½" PIPE (1.610" ID)						
1					.37	.11									1
2					.74	.39	.43	.10							2
3					1.11	.82	.64	.21	.47	.10	2" PIPE (2.067" ID)				3
4					1.49	1.37	.86	.36	.63	.17					4
5					1.86	2.08	1.07	.54	.79	.26			2½" PIPE (2.469" ID)		5
6					2.23	2.83	1.28	.76	.95	.35	.57	.10			6
8					2.97	4.68	1.72	1.29	1.26	.61	.76	.17			8
10	3½" PIPE				3.71	7.12	2.14	1.95	1.57	.90	.96	.26	.67	.11	3" PIPE (3.068" ID) 10
15	(3.548" ID)				5.56	15.0	3.21	4.06	2.36	1.87	1.43	.54	1.00	.23	15
20					7.41	25.6	4.28	6.80	3.15	3.12	1.91	.92	1.34	.38	.87 .13 20
			4" PIPE												
25	.61	.10	(4.026" ID)				5.35	10.3	3.94	4.70	2.38	1.39	1.67	.58	1.08 .20 25
30	.97	.13					6.43	14.4	4.72	6.60	2.86	1.92	2.00	.81	1.30 .28 30
40	1.30	.23	1.01	.12					6.30	11.2	3.82	3.35	2.68	1.36	1.73 .47 40
50	1.62	.34	1.26	.18	5" PIPE				7.87	16.6	4.77	5.00	3.34	2.06	2.16 .72 50
60	1.94	.48	1.51	.25	(5.047" ID)						5.72	7.00	4.02	2.85	2.60 .99 60
70	2.27	.63	1.76	.34	1.12	.11	6" PIPE				6.68	9.40	4.68	3.80	3.03 1.33 70
80	2.59	.82	2.01	.43	1.28	.15	(6.065" ID)				7.62	11.9	5.35	4.95	3.46 1.72 80
90	2.91	1.00	2.27	.54	1.44	.18					8.60	14.7	6.02	6.05	3.89 2.13 90
100	3.24	1.24	2.52	.65	1.60	.22	1.11	.09			9.56	18.7	6.70	7.47	4.83 2.58 100
125	4.05	1.82	3.15	1.00	2.00	.33	1.39	.13					8.37	11.1	5.41 3.90 125
150	4.86	2.55	3.78	1.39	2.40	.47	1.66	.18	8" PIPE				10.0	15.4	6.50 5.44 150
175	5.66	3.40	4.40	1.90	2.80	.62	1.94	.24	(7.981" ID)				11.7	20.8	7.58 7.30 175
200	6.48	4.35	5.04	2.40	3.20	.80	2.22	.31							8.66 9.18 200
225	7.30	5.44	5.66	2.98	3.60	.97	2.50	.38	1.44	.10					9.75 11.6 225
250	8.10	6.59	6.29	3.68	4.00	1.19	2.77	.47	1.60	.12					10.8 14.0 250
275	8.91	7.90	6.92	4.35	4.40	1.43	3.05	.56	1.76	.15	10" PIPE				11.9 16.9 275
300	9.72	9.30	7.55	5.04	4.80	1.65	3.32	.66	1.92	.17	(10.020"ID)				13.0 19.6 300
350	11.3	12.2	8.80	6.85	5.60	2.21	3.88	.88	2.24	.23					350
400	13.0	15.9	10.1	8.67	6.40	2.89	4.44	1.12	2.56	.29	1.62	.10			400
450	14.6	20.0	11.3	10.9	7.20	3.56	4.99	1.40	2.88	.37	1.82	.12			450
500			12.6	13.3	8.00	4.36	5.54	1.72	3.20	.45	2.03	.15			500
550			13.9	16.0	8.80	5.17	6.10	2.06	3.52	.55	2.23	.18			550
600			15.1	19.1	9.60	6.16	6.65	2.42	3.84	.63	2.44	.21			600
650					10.4	7.22	7.20	2.78	4.16	.73	2.64	.24			650
700					11.2	8.29	7.75	3.25	4.47	.85	2.84	.28			700
750					12.0	9.40	8.31	3.63	4.80	.97	3.04	.31			750
800					12.8	10.3	8.87	4.11	5.11	1.11	3.25	.35			800
900					14.4	13.0	9.96	5.12	5.75	1.33	3.65	.44			900
1,000					16.0	15.8	11.1	6.17	6.40	1.64	4.06	.55			1,000
1,100					17.6	19.0	12.2	7.45	7.04	1.98	4.46	.64			1,100
1,200							13.3	8.73	7.67	2.36	4.87	.75			1,200
1,300							14.4	10.2	8.31	2.71	5.27	.88			1,300
1,400							15.5	11.9	8.95	3.10	5.68	1.02			1,400
1,500							16.7	13.2	9.60	3.49	6.09	1.18			1,500
1,600							17.8	15.0	10.2	3.92	6.49	1.31			1,600
1,800							20.0	18.5	11.5	4.99	7.30	1.60			1,800
2,000									12.8	5.96	8.11	1.97			2,000
2,500									16.0	9.00	10.2	2.95			2,500
3,000									19.2	12.5	12.2	4.15			3,000
3,500									22.4	16.6	14.2	5.60			3,500
4,000											16.2	6.90			4,000
4,500											18.3	8.80			4,500
5,000											20.3	10.8			5,000
5,500											22.3	13.0			5,500
6,000											24.4	15.3			6,000

VEL.—Velocity in feet per second. FRIC.—Friction head loss in feet of water per 100 ft of pipe

With smaller steel piping, it is likely best to consider what the friction head will probably be when the pipe is new and to make allowance for an increase in the loss based on local conditions. Lacking any basis of comparison, allowing for a 25 per cent increase in friction with age would be a reasonable assumption.

A friction table for water for new steel or wrought iron pipe is shown as Table II, page .... Drawn brass or copper pipe would have a somewhat lower loss. This table is based on the Darcy formula, which is:

$$h_f = f \times (L \div d) \times (V^2 \div 2g)$$

where h_f = loss in head in feet of liquid

L = length of pipe in feet

D = inside diameter of the pipe in feet

V = velocity in feet per second

g = acceleration of gravity (32.2)

f = a factor dependent upon the relative roughness of the pipe, the velocity, the size of the pipe and the viscosity of the liquid.

This is a more scientific formula than the Williams and Hazen and is generally used in determining friction values where liquids other than water are being handled.*

*See Friction Factors for Pipe Flow, by Lewis F. Moody; *Transaction of ASME* for November, 1944.

How Molten Metal Makes Repairs

Nearly all types of metals and many non-metallic materials, flat work and shafting may be repaired or maintained by the use of metal spraying . . . Small jobs and big ones show savings . . . Length of life of some parts increased 5-fold by metallizing

By HOWARD BATSFORD,
Metallizing Engineering Co., Inc.

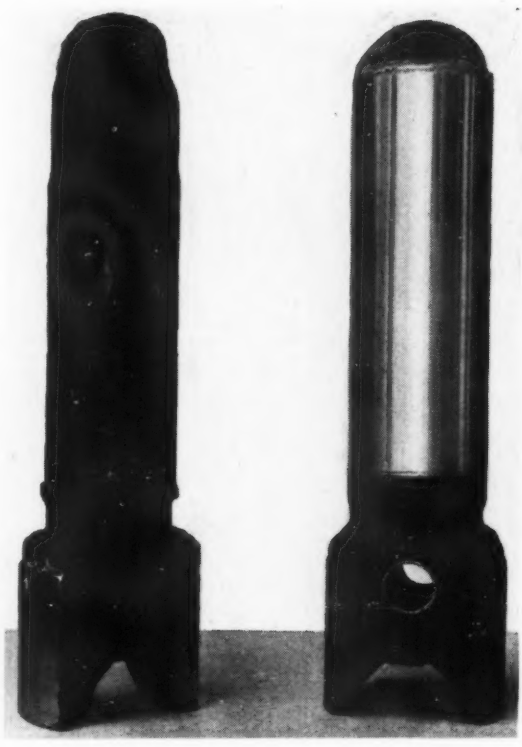


Fig. 2. Here is a before-and-after metallizing photograph. A pump piston is shown, worn and corroded, at the left. At the right it is completely refurbished with a metallized bronze coating. The cost of this job was figured to be only one-fifth of the cost of replacing the part

METALLIZING as a process for building up worn parts is an invaluable aid to the plant engineer. Simple and economical, it effects savings in the upkeep of plant equipment and often imparts a longer life to the repaired part than a replacement would afford.

Armature shafts, pump rods, pump sleeves and impeller shafts, crankshafts, large and small shafts of all kinds; cylinder liners and casings, anti-friction and sleeve bearings, press fits—these are some of the types of parts which can readily be restored to their original size through metallizing.

Utilizing a light-weight "gun" which can be mounted in a lathe or held in the hand, the process applies any metal that can be supplied in wire form onto any metallic surface, and onto many non-metallic ones. These guns feature minimum operator adjustment and minimum skill to operate.

Metallizing guns are versatile. The larger gun, which handles up to 3/16 in. dia wire, will spray 20 lb of 10-carbon steel in an hour for instance —a great help on maintenance jobs calling for quick repair of large equipment with a minimum of downtime. In fact, repairs often are made in regularly scheduled downtime. Yet the process handles the smallest of jobs too—shafts half an inch in diameter for example—with equal ability; and it is much used on flat work also.

Since the bond between the work and the sprayed metal is a mechanical one, the surface must first be roughened. This is best accomplished on machine work by threading and then mushrooming the tops of the threads to form a greater dovetail effect, or by using an electrically deposited foam of a high nickel alloy. Flat work is blasted or electrically prepared as above. Sometimes parts of the above methods are combined.

The particles of sprayed metal strike the surface and flatten out, cooling almost instantly, and form a stratified structure of interlocking particles which is partially pervious. This gives sprayed metal better wearing qualities than the same metal in the rolled or cast form. Finishing is accomplished by turning, grinding, or other standard machining operations.

Experience has shown such startling records as a five-fold increase in the

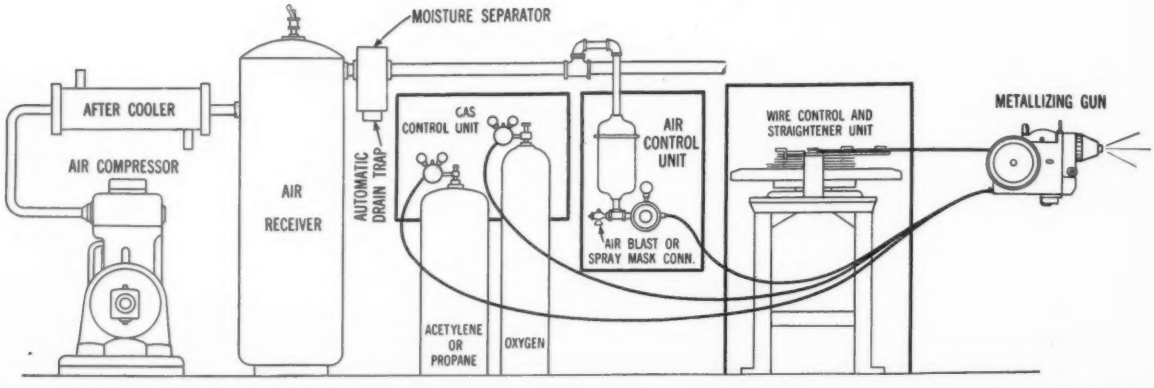


Fig. 1. This drawing shows how a typical metallizing layout is arranged. The equipment shown is that required to insure trouble-free operation

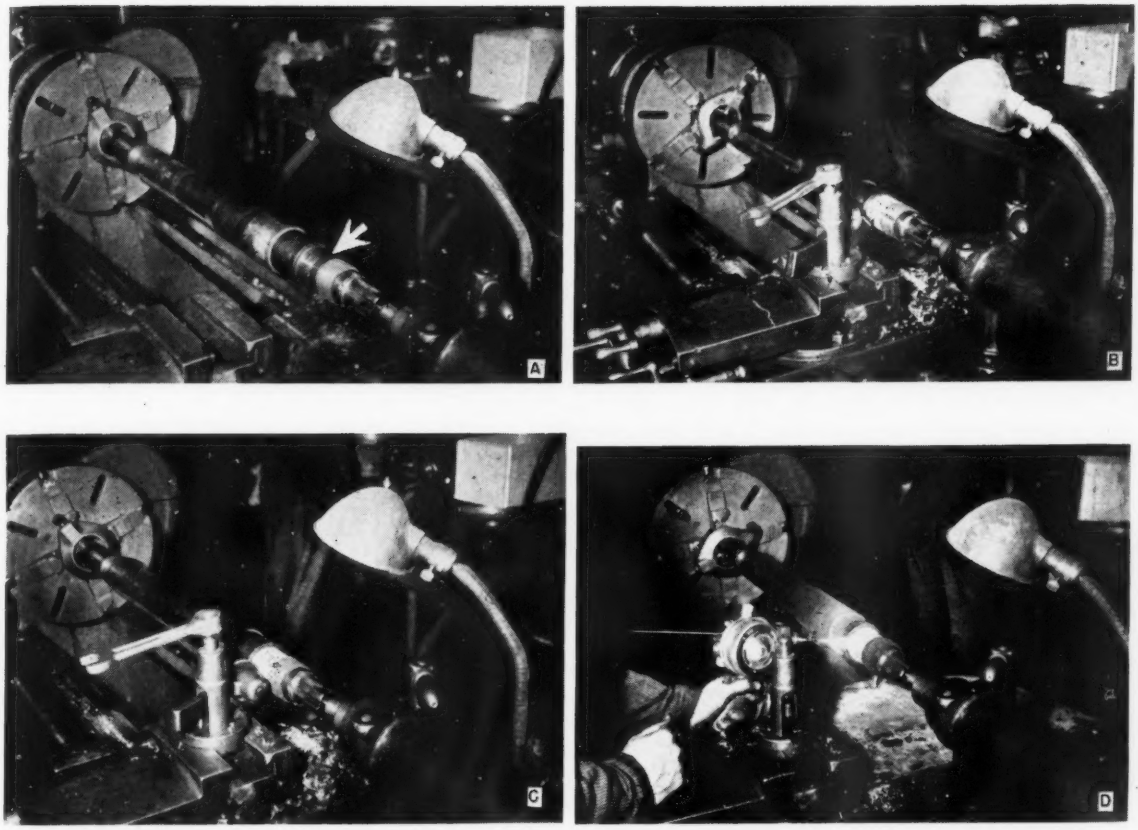


Fig. 3. This series of photographs shows an armature shaft being repaired for $10.00 at a saving of $65.00 over replacement cost. In photo A the arrow indicates where the shaft was scored and worn by a frozen ball bearing. B shows where the shaft was undercut about 1/8 in. on the diameter at the worn section. At C the shaft is prepared for spraying with a special roughening tool. D shows the actual spraying operation. After spraying the bearing fit is machined and the shaft will be ready for service again

operating life of equipment through the application of alloy coatings over original shafts of carbon steel; and the saving of $1,500-$2,000 on the repair of a crankshaft main bearing journals of a 13 in. x 24 in. two-cylinder double acting ammonia compressor, doing all the work with the 2,000 lb shaft in place in the machine.

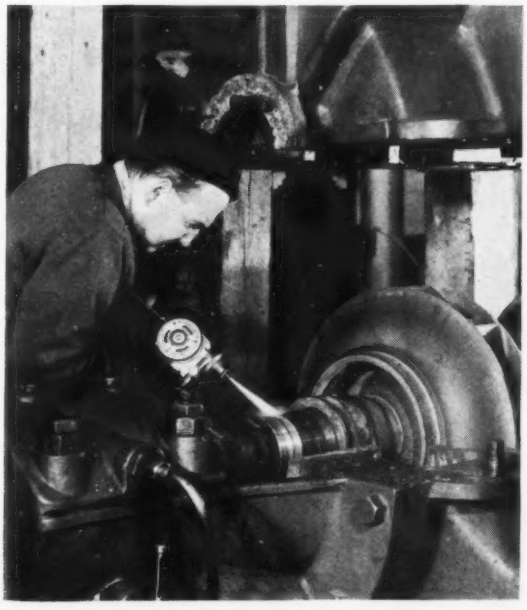


Fig. 4. A 24 hour repair job saves 9 days time. Phosphor bronze packing gland sleeves of 12,000,000 gph water pump, scored at both outer ends, are rebuilt by metallizing

ALL MOTOR CONTACTS should be checked periodically. If burned they should be smoothed with a file, sandpaper, or abrasive cloth. If badly burned, they should be replaced with new ones. Do not file or sandpaper the contact more than necessary. Carefully remove all dust and abrasive material from the contact surfaces before placing back in service.

DIRECT COMPARISON between radiant and convection heating will be available in a new student apartment building under construction at Georgian School of Technology campus. This is an eight story structure built in two wings, with a calculated heat loss of 750,000 Btu per hr per wing and an outside of temperature of plus 10 deg.

Steam at 25 lb pressure will be used with one 5,000 gph heat exchanger for each system. Circulating water for the radiant system will be controlled at from 120 to 140 deg F, that for the convection heated wing at 180 to 200 deg F.

HOW TO MAINTAIN MOTORS

By C. G. GRANT

Motor Division, General Electric Company, Schenectady, N. Y.

Part II. Disassembling and reassembling motors and generators . . . Care of insulated windings . . . Testing insulated windings . . . Tests for general conditions . . . Tests for locating grounds . . . Tests for defects . . . How to check for polarity . . . How to check voltage drop on coils . . . Temperature readings

AN IMPORTANT factor in the maintenance of motors and generators is that of disassembly and reassembly. A fairly simple task can be made complicated by using improper methods in this respect. The following suggested procedure indicates a systematic process with necessary safeguards for parts and personnel at each step. Disassembly work may be performed at the motor operating point, but it is recommended that such work be performed in a shop where the parts may be kept clean and in good order.

1. Coupling-halves, pulley, pinions and fans should be removed by a puller. It is emphasized that a puller should be used to avoid hammering and wedging which will likely injure parts of the motor and possibly personnel.
2. Bearings containing oil should be drained.
3. Check air gap for bearing information which will be of use later.
4. Remove brushes.
5. Remove end shields.
6. Remove fan, if any.
7. If necessary to remove ball bearings, use a puller. Detailed procedure is covered under the heading of "Bearings."
8. Remove motor. Heavier rotors or armatures should be removed with the aid of rope slings. Dragging over punchings should be avoided.
9. Remove and tag small parts such as field connections, yokes, brush holders, collector rings, etc. They should be cleaned and placed in a clean place in order of removal.
10. All parts should be thoroughly cleaned and placed where they will not be moved until ready for reassembly. Avoid bruising or cracking the insulation on all parts. A typical disassembled fan-cooled induction motor is shown in Fig. 1.

Reassembling

1. Parts must be clean.
2. Do not force parts together if binding is encountered. Find the trouble rather than mar or distort the parts.
3. Reinstall all small parts and enclosing features. Explosion-proof motors require great care in maintaining exact fit at all joints.
4. Check air gap again and compare with previous check. If no new sleeve bearings were added, the air gap should be the same as when disassembled.
5. Make sure fans have been replaced and lubrication has been provided.
6. Be sure that motor is properly lined up before it is put back in service.
7. Reconnect ground wire and check connection diagram, especially on two voltage motors.
8. Turn motor by hand, or if connected to load, by lever, if possible. Note any noises or binding and make corrections.
9. Apply voltage and operate motor unloaded, noting any noises. Note lubrication and ventilation.
10. Remove all extraneous material from around the machine.
11. Make a special inspection within a few days after putting motor back in service.

Insulated Windings

Insulation on windings is the most delicate part of a motor or generator. Its care is essential to the efficient operation of the equipment. Further, records indicate that most of the trouble in motors or generators, is caused by a breakdown of the insulation, attributed to lack of cleaning and care of the insulated windings. We can therefore see that proper maintenance of windings is mandatory for efficient over-all plant operation.

Testing Insulated Windings

TESTS FOR GENERAL CONDITION:

Megohms (million ohms) of resistance between a winding and ground is a good indicator of insulation condition. Comparison with several previous readings will give an indication of improvement of deterioration. Readings should be taken with the machine at normal working temperature. Readings, to have com-

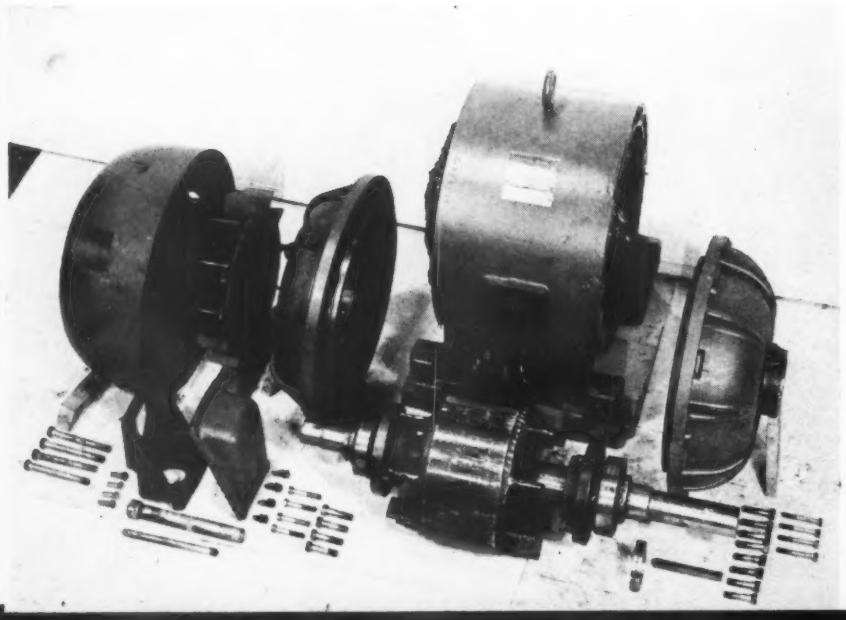


Fig. 1. This motor was disassembled and the parts cleaned and arranged in an orderly manner for easy assembly

AND GENERATORS

parison value, should be taken under the same conditions.

Two methods of obtaining resistance readings are commonly used:

1. A megohmmeter (not a magneto) is a self-contained instrument which gives a direct reading of insulation resistance. Follow instructions furnished with instrument. Although cranked by hand, the megohmmeter provides constant voltage while the clutch is slipping, and the index should read "infinity." When connected across the resistance to be measured and cranked beyond the slipping speed, the resistance is indicated directly.

2. The voltmeter method using a d-c power source requires a voltmeter having a resistance of about 100 ohms per volt. A 500-volt d-c instrument is preferred. Disconnect all leads of the motor from the line. In case of heavy loads, line power can be broken at the circuit breakers or disconnecting switches, if proper precautions are taken to prevent power from being turned on accidentally while work is being done on the machine. Read line voltage, which will be E in the formula. Now connect the undergrounded d-c line through the voltmeter to a motor lead, and the other d-c line through a 10-amp fuse to the motor frame. Meter reading is E_1. With r representing meter resistance, and R the insulation resistance in megohms:

$$R = r \times \frac{(E - E_1)}{E_1}$$

Example: $R = 50{,}000 \times \frac{230 - 60}{60} = 0.142$ megohm

Either the megohmmeter or the voltmeter method may be applied to any high resistance, such as the insulation of a group of coils, as well as to that of a whole machine.

AIEE Standards establish the following "Normal Insulation Resistance Value":

$$\text{Megohms} = \frac{\text{Rated voltage of machine}}{\frac{\text{Rating in kva} + 1000}{100}}$$

This will work out to about:

220-volt motor—0.2 megohm
440-volt motor—0.4 megohm
550-volt motor—0.5 megohm

TESTS FOR LOCATING GROUNDS:

D-C Windings—If a low-resistance ground in armatures with commutators has been developed, it may quickly and accurately be located by the following method: a low-voltage current, which is sufficient to give a readable deflection on a galvanometer or millivoltmeter, is passed through the armature windings from one commutator bar to the next, as shown in Fig. 2. A line is connected from the galvanometer to the ground, and the other galvanometer connection is placed on one of the commutator bars. The supply and galvanometer leads are then passed from segment to segment. When a full deflection is obtained, the coil is grounded.

A-C Windings—In testing for grounds, the methods and apparatus are similar to those used on d-c machines, except that with a-c the voltage generated is usually higher. Consequently, testing voltages are higher and greater care should be taken in testing. Place equipment as close to the apparatus as possible to maintain voltage at receiving and operating end as near the same as possible. This precaution is necessary to avoid excessive voltage on the windings, causing damage to the insulation. If a ground develops, a resistance measurement will generally locate the point at which it occurs, unless each phase has two or more multiple circuits. In this case, it may be more readily located by opening one or more of the end-connection joints, and separating the circuits.

A measurement may be taken as shown in Fig. 3 which represents a single circuit or phase of an alternating-current machine, with the ground as shown. If the resistance between

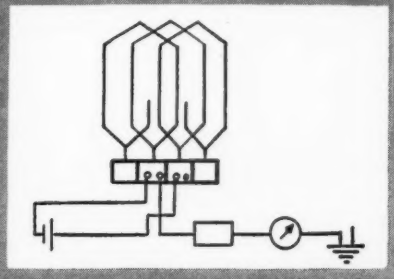


Fig. 2. Connection hook-up which can be used to test grounds. A low-voltage current, which is sufficient to give a readable deflection on a galvanometer or millivoltmeter, is passed through the armature winding from one commutator bar to the next

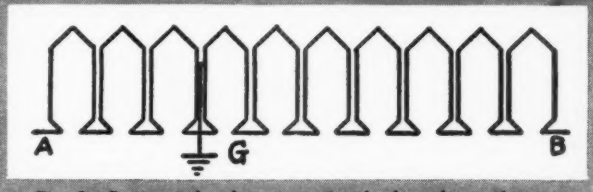


Fig. 3. An example of a connection hook-up for testing an alternating-current winding with 10 coils in series

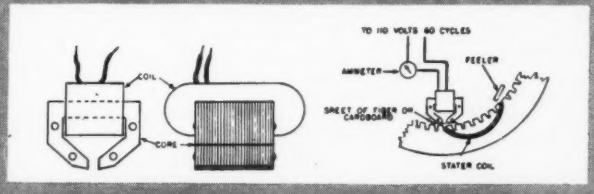
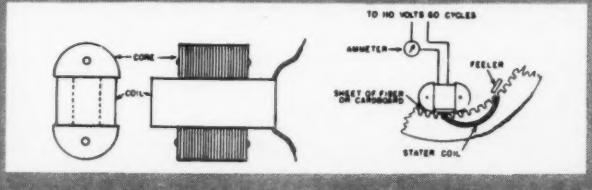


Fig. 4. Two types of growlers. Above is a type of growler that can be made for testing motors for short circuits in the stator winding. The one below of different construction can also be used for testing short circuits in stator windings



A and B is one ohm, between A and G is 0.35 ohm, and between B and G is 0.65 ohm, the location of the ground is 0.35 of the distance between A and B, from A. Since ten coils are in the circuit, the measurements show that the fourth coil is grounded, counting from A.

TESTING FOR DEFECTS:

D-C Machines—Measuring the ohmic resistance of the winding will sometimes reveal a wrong connection, which, on a bar-to-bar measurement, would give a uniform deflection all around the commutator. Series or wave windings may sometimes have all conductors joined in series but in the wrong order, making the armature inoperative. In case of multiple or lap windings—double-, triple-, or even quadruple-spiral re-entrant windings are possible, whereas a single spiral is required. In taking a resistance measurement of the armature, see that the measurement is made from the proper commutator segments.

Special clips are attached to the commutator bars, and spaced the number of bars apart equal to the total number of bars divided by the number of poles. Each alternate clip is connected in parallel to one terminal of a double bridge, and the remaining clips are connected in parallel and to the other terminal of the double bridge. The resistance reading then obtained is the true running resistance.

A-C MACHINES:

In the case of an alternating-current winding, the ohmic-resistance measurement will not always detect a wrong connection, such as a reversed coil, pole section, or phase; for, although the copper resistance would be measured correctly, the total winding might be partly reversed, and, therefore, inoperative. Such faults can be discovered by a polarity or impedance test with alternating-current. For this purpose, a single-phase current can be used, since a reading may be taken on the different circuits or between pairs of terminals successively, by shifting the testing lines until all windings have been tested.

Short-circuited coils on moderate-size machines can readily be tested by using a wound electromagnetic yoke, or "growler," excited with alternating-current. This yoke is placed over a portion of the winding with the coils in their slots. The yoke and windings form an alternating-current transformer, with a yoke winding as primary, and the winding coils as secondary (Fig. 4). If there is a short-circuited turn, layer, or coil in the motor, the magnetizing current in the yoke winding will rise. If the current is maintained for a short time, the insulation on the short-circuited section will warm up appreciably, or burn sufficiently to indicate the defective coil.

On alternator windings, tests can be made for short circuits by passing alternating-current through the armature coil itself. In this case, it is usually necessary to increase the reactance of the coil by placing a magnetic bridge over its coil slots, after it has been assembled in the core.

How to Check Shunt Windings for Polarity

To test for the opposite polarity of alternating poles, bridge two pole tips with a piece of soft iron. If the polarities of the poles differ, the piece will be strongly attracted, whereas, if the poles are of the same polarity, there will be no attraction. Polarity can be tested by use of a compass, but the compass must not be carried too near the poles, as it may be demagnetized, or even reversed.

How to Check Voltage Drop on Coils

With a given current flowing through the field, the voltage drop on any coil of a direct-current machine should never be more than 5 per cent higher or lower than the average drop, except single-turn series coils, which may have a variation of 10 per cent. In alternating-current machines, no coil should vary more than 5 per cent either way from the average. If the drop is outside these limits, the matter should be referred to the maintenance engineer for instructions. After assembly on the spider, field coils for alternating-current apparatus are tested in the same manner as prescribed for direct-current machines. In addition, the coils are checked for impedance by applying a high-frequency voltage to each coil, and measuring the current flow. The current will increase considerably, if there are any short-circuited turns. In recording drop on the coils in alternating-current machines, number them in a clockwise direction, facing the collector end, and beginning at the coil next to the opening in the field, for coil No. 1.

In direct-current machines, for record purposes, coil No. 1, either main or commutating, is the top coil or the next adjacent in the clockwise direction facing the commutator end.

RESISTANCE:

When testing a machine, a very careful record must be kept of the resistances of all the windings. For measuring the shunt-, commutating-, and series-field resistances, the voltage-drop method may be used.

HIGH-POTENTIAL TESTS:

If a megohmmeter reading indicates low resistance or the presence of a ground, and a high-potential test seems advisable, refer to a service shop for testing.

TEMPERATURE READINGS:

The AIEE Standards, No. 1, June, 1940, recommend that hottest-spot temperatures should be limited as shown in Table I.

Table I. Hottest spot temperature should be limited as shown below

Classification	Limit	Assumed Equal Observable Reading		
		Thermometer	Resistance Method	Embedded Detector Method
Class A insulation (cotton, silk, paper, impregnated enamel)...	105 C	90 C	100 C	100 C
Class B insulation (inorganic materials such as mica or asbestos with binding substances)	130 C	110 C	120 C	120 C

Above based on assumption of room temperature of 40 C.

Ventilating Hints

VENTILATING EQUIPMENT provides basic protection from health and fire hazards in the solvent department, and should be inspected regularly. Even well-designed ventilating systems will become inefficient unless properly maintained. To eliminate the five most common causes of failure of ventilating equipment, the following points should be checked, says the Safety Research Institute.

Is the Fan Running Backwards? Strangely enough, this is the most frequent reason for failure of correctly designed equipment. Sometimes a fan requires repairs, and then is reversed when it is started up again. A regular check on the direction of fan motion is important.

Is the Fan Belt Loose? Loose belts cause the fan to run too slowly. Since new belts generally loosen up somewhat after use, they should be adjusted after installation.

Is the System Overloaded? While a system may be correctly designed for the initial load, it often happens that additional outlets are later added, reducing the overall efficiency of the equipment. The velocity of the air stream should be measured regularly, and whenever additional ducts are added.

Are the Ducts and Blades Dirty? Dirth in a ventilating system is a frequent cause of breakdown and inefficient operation. Systems should be cleaned regularly. Fans should be run for a few minutes after operations are finished, to allow for complete emptying of the ducts.

Is There Insufficient Make-Up Air? Since ventilating equipment exhausts air, it cannot run efficiently unless there is provision made for enough make-up air to enter the room.

We Advance Through Research but MAINTENANCE Keeps Us Going

By H. R. MEYER

Manager, Maintenance Sales, Westinghouse Electric Corp.

In the first article under this title in the November issue, Mr. Meyer discussed the general aspects of maintenance and maintenance programs. Now, he directs attention to a number of specific new methods which have been developed during the past years which will help every operator in the care and maintenance of his equipment

IN THE FIRST article in the November issue, I discussed the general aspects of maintenance of electrical equipment. Now, I am going to take up a number of new developments which will help in the maintenance of motors, generators and other electrical equipment.

The use of glass insulation and Silicones in connection with the maintenance of motors was described in some detail. Such insulation is useful on all types of motors and generators. In the case of the d-c machine there is involved the commutator and the connection of the armature coil leads to it.

There is involved a commutator and the connection of the armature coil leads to it in the case of the d-c motor. General practice has been to use a tin or tin-lead solder to secure the leads to the commutator neck. It should be obvious that with the relatively low melting point of common solder it will not do for Silicone work. When temperatures are not too high some commutator connections have been successfully soldered with a so called high temperature solder. However, for high temperature operation it is necessary to use a joining material with a relatively high melting point. Phos copper, because of its higher melting point, is very satisfactory for brazing the lead to the commutator neck.

As phos copper melts and flows around 815 C, there is little to fear from open circuits at the brazed joints caused by temperatures that will not ruin other parts of the machine. Like many other operations, a technique is required but it is simple in character and needs no special skill. If certain precautions are taken good joints can be obtained. After a joint has been made it can be unbrazed and rebrazed at least three times without adding any new brazing material.

When brazing connections between coils in the stators of large a-c motors, phos copper in thin sheet form is placed between the leads of two coils and these, in turn, are held together with the brazing tongs. Current is applied and the joint heated until the phos copper melts and flows between the leads. When brazing armature coil leads in a commutator neck of a d-c motor the problem is a little different. Experience in this work has shown that the operation is most successful where the neck of the commutator is higher than the brush surface. Such construction permits the heat to be applied in the shortest possible time with the least amount of damage to the commutator copper. Some difficulty has been encountered on commutators where the neck is the same height as the brush surface. This is due to the fact that it is hard to localize the heating during the brazing operation.

Another factor that must be kept in mind in the construction of present day commutators is the insulating segments between the copper bars. These are made of built-up mica with a suitable bonding material. Theoretically, in a seasoned commutator the bonding material, so far as the solvent is concerned, should be rather well baked out. However, there is still some question as to whether present day construction is satisfactory for the maximum temperatures under which machines can operate when insulated with Silicone. As a test to determine just what could be done a number of d-c railway motors were built with Silicone insulation and a special synthetic bond for the mica in the commutator segments (not Silicone). These motors have been in service over two years and are still going strong.

One of the greatest boons to the electrical industry, and no doubt to many others, is the development of a

Fig. 1. A 10 kva brazing transformer. 220 v primary, 8, 10, and 12 v secondary, 833 amperes

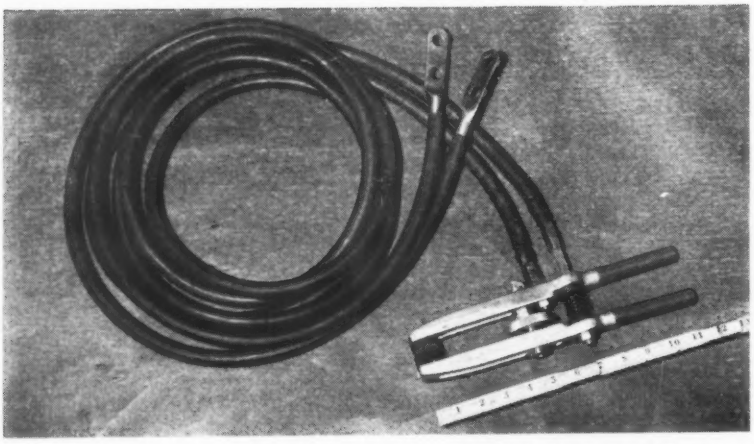


Fig. 2. Air cooled brazing tongs showing method of cable connections

copper alloy that can be made into springs of various forms; that can be held to very close tolerances; and, that will retain its characteristics over long periods of time. Maintenance men who have had to rely on phosphor bronze springs, when steel would not stand up due to damp and corrosive atmospheres, will realize just what this means in the upkeep of their equipment. Phosphor bronze, at best, is a poor substitute for steel due to the very nature of the material. In the first place it has a definite grain structure, and, unless the finger or spring is punched or cut with the grain, it will take a set under only a slight excess of bending. If the spring can be rolled to the right size the characteristics are good but many types of springs must be punched out of sheet.

With beryllium copper the spring shape can be punched from the soft sheet. Hardening and tempering is accomplished by heat treating. During the heat treating process the punched shape is held in a jig so that the finished product will be to dimensions and of the predetermined shape. It is amazing what can be done with this relatively new material and I venture to say that it will go a long way in the solution of many of the temper raising troubles that occur when a little spring can cause a whale of a lot of trouble.

This much abused method of building up worn parts is really a friend of the maintenance crew when a machine must be gotten back on the line in the shortest possible time. While it is a definite recommendation that a worn part should be replaced with a new one it has been impossible for many years to get replacement parts when they were needed. Of course, the best insurance against such delays is an adequate stock of renewal parts, although I know it has been impossible to keep even a minimum amount on hand.

The building up of worn parts by the metal spraying system has, in many cases, failed miserably through a lack of knowledge on the part of the operator rather than an inherent weakness of the idea. There are a number of factors in the process that must be considered if a good job is to be done. In the first place, the preparation of the work piece must be handled correctly or the operation will fall very much short of the desired goal.

During the World War II, which is still going on under an undisclosed agreement to carry on with words instead of bullets, this process made possible the repair of many things that would have otherwise been scrapped. In our Navy Yards many foreign submarines were rebuilt. As there were no renewal parts available, bearing fits in housings were built up; journals on shafts returned to original size; and, many other operations performed. Equipment was placed back in service months, and possibly years, before it would have been possible by any other method.

In the transportation game, on both cars and busses, many parts were reclaimed. Renewal parts, particularly for busses, were almost impossible to get and transportation for war workers was a must. I have seen journals on the axles of street cars that were built up with apparently satisfactory results. With all of this we must still keep in mind the fact that limitations are still a question

Fig. 3. Demonstrating the method of brazing coil leads on a-c generator

of application of the machine involved and the work to be done. The process is emphasized because this is another way of conserving materials.

With infra red heat lamps it is possible to perform a number of drying and baking operations which heretofore required rather extensive oven installations. It does not, for many operations, replace oven baking but can be considered as an adjunct for many problems where an oven is not available. Again, it can be used when an oven would not be feasible. As it provides a radiant heat rather than one of convection, greater immediate penetration is obtained with consequent shortening of the baking period.

Great flexibility of setup is possible as the source of heat (the infra red lamp) is of such size that any number can be assembled to meet a given need. With a given bank or assembly of lamps, heat can be applied as and where needed by means of wiring and switching arrangements. The process lends itself particularly well to small operations and when the baking must be done in the shortest possible time. For general run of mind baking work it is somewhat more expensive than regular oven baking. Baking problems must be studied from all angles but there will always be many applications where infra red can be used to good advantage.

The growth and development of our direct current motors and generators is tied in directly with the development of the carbon, graphite, electrographite, and metal graphite brushes. In the early days of the d-c motor the only brushes available were of the leaf copper and woven copper gauze type. A limit in the capacity and voltage of such machines was definitely determined by the limited commutating ability of this form of brush. Characteristics of the carbon brush are such that a resistance to the flow of short circuit currents is provided which permits the handling of larger amounts of current without excessive arcing between the brush and the commutator.

Solve Commutating Problems with Brushes

Ever since the advent of the carbon brush many improvements in materials and processes have been made until, today, practically all commutating problems can be solved, at least from the brush standpoint. There are still some types of machines that present problems for further study but there have also been cases where the brush is expected to overcome faults in the machine design. During the past few years new theories regarding commutator surface films have been evolved. When it became necessary to provide relatively large amounts of electrical energy for bombing planes in the recent war, the only machines suitable were of direct current design.

Small d-c generators of about seven kilowatts capacity were connected directly to each engine. Whereas little or no difficulty was encountered at 15,000 to 20,000 feet altitude, it was soon discovered that at 30,000 feet the brushes on the generators would not last for one short flight. Investigation indicated that at this altitude the film on the surface of the commutator was lost and it became a miniature grindstone which soon reduced the brush to powder. Apparently at this height above the earth the small amount of oxygen and the lack of moisture combine to prevent the formation of a suitable surface film. This led to an intensive research program to develop a brush that would either supply its own surface film or act as a catalyst in making use of the little oxygen available

Many years ago the Westinghouse Co. recognized the necessity of combining machine design talent with engineering in the carbon brush industry to produce the best commutation. It was realized that these two arts or sciences were inseparable if the best possible results were to be obtained. That this idea was sound is attested to by the fact that it was this combination that produced the only suitable brush for d-c generators operating at 30,000 ft and above. This cooperative development resulted in the so called high altitude treatment for electro-graphic brushes.

It was soon realized that what was a solution for upstairs problems might also, in a modified form, take care of some of the troubles we were having on machines operating at sea level. To this end a study was started with machines operating in contaminated atmospheres. In some cases considerable success has been obtained; while, in others, the results have been only fair.

While the hypersil core was not a war development, its availability was most certainly a gift from heaven to the radio, and particularly the radar industry. It was originally designed for our standard distribution transformers and through its use the weight of the complete unit was reduced about 30 per cent. This idea, the result of much research work to increase the permeability of electrical sheet steel, was the greatest gain in this direction for many years. As an outgrowth of this discovery the radio industry was supplied with large quantities of small cores, which was just the thing needed to help reduce the weight of equipment for planes.

The basic material for the hypersil core is rolled and heat treated at the steel mill in such a manner that the cube edges of the individual crystals of the crystal lattice are all lined up parallel with each other and with the direction of rolling. It is this preferred orientation which gives the material its superior magnetic qualities and makes it possible for the designer to reduce the size and weight of the transformer. To form the core, a ribbon of hypersil is wound on a steel mandrel having dimensions which will give the desired opening for the coils. After the resulting core loop has been annealed, it is impregnated with a special synthetic compound which bonds each layer of ribbon to its neighbor. The core loop is then cut in two segments which are

Fig. 4. Metal spraying to build up worn parts (See detailed article, page 52)

re-assembled about the coils and permanently held together by a special steel ribbon and lock.

One of the advantages of this new core, especially for the central station industry, is found in the fact that a 3 kva core and coil unit can usually be placed in an old 1½ kva tank and no change is required in pole mounting. Likewise a 5 kva unit, in most instances, can be placed in a 3 kva tank. Many users of transformers have found that for many applications the 1½ kva size has proven to be inadequate after it has been installed for a short time. Here is an opportunity to obtain a practically new transformer with increased capacity, without a change in pole hangers.

Today, you can send a 1½, 3, or 5 kva transformer of almost any make, using a steel tank, to any one of our thirty-seven repair shops and have it returned to you with brand new hypersil core and coils. In most constances, the old transformer can be up-rated by making the 1½ into a 3, or the 3 into a 5 kva capacity transformer. This is a move that really conserves material and is a distinct advance in maintenance.

There are many other interesting developments that might be enlarged upon but space will permit only a few of those most pertinent to maintenance work. In addition to those already mentioned the following are worthy of mention:

1. Arc welding—One of the greatest single blessings of maintenance.
2. Thermal cutouts to protect motor windings.
3. Compensating fingers with tips that follow the contour of the contact.
4. Brusholder finger springs which reduce the number of brushholder parts.
5. Silver inserts in contact tips to reduce heating.
6. Non-magnetic banding wire.
7. Sealed pre-lubricated ball bearings which will run for five years or more without attention.
8. Fosterite—A synthetic compound for encasing operating coils where excessive moisture exists.
9. Chrome nickel steel shafts to replace axle steel for heavy duty.
10. Heat treated steel bolts.
11. Coronox treatment for end windings on high voltage machines to eliminate corona.
12. Metal spraying of zinc as a rust resisting coat for metal surfaces exposed to elements.
13. Dynamic balancing.
14. Surge impulse testing of repaired apparatus.
15. High frequency testing.

A number of years ago, Einstein worked out the theory that, in destroying matter, (I was a little surprised at this statement as we were taught years ago, in physics, that matter can neither be created or destroyed) the amount of energy released was equal to the original weight of the matter multiplied by the square of the speed of light. The square of the speed of light is about 35,000,000,000, so that it wouldn't take much matter to create a lot of energy.

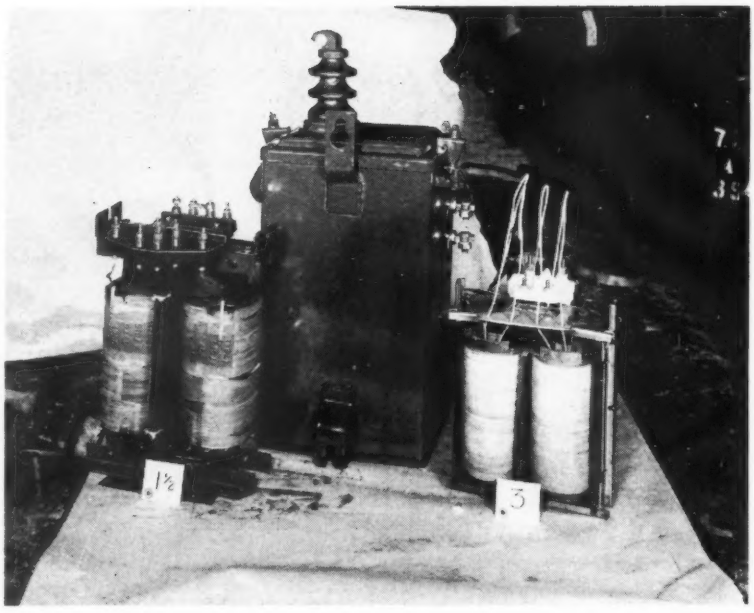


Fig. 5. Hypersil cores and coils which reduce weight of transformers 30 per cent

I have quite often felt that if we could take only a small amount of gray matter and multiply it by just a little bit of speed of light, and then apply that action to our maintenance problems, a big improvement could be made.

I do not think that our lack of attention to maintenance details is due to indifference but rather to the fact that, in itself, this operation lacks the romance that is attached to the manufacture of new apparatus. It is also true that maintenance is rather humdrum work with pretty much the same operations being performed day after day. A good example of the attitude towards this most necessary function of our daily economy is found in the actions of many operators in past years of cutting first, maintenance expense when business started to drop off. There were some exceptions, of course, to this. Andrew Carnegie was one of the greatest exponents of the idea of setting aside money during prosperous periods to take care of the rebuilding of his plant during dull times.

Westinghouse realized a number of years ago that they were not doing all that could be done to assist the operators of its equipment to do a complete maintenance job. To help take care of this situation there was established in 1941, a complete maintenance organization throughout this country. It is the duty of this department to coordinate the functions involved in furnishing renewal parts; the repair of electrical equipment in its repair shops located throughout the country; and, the repair of large machines in the field that cannot be moved into the shops.

There is in each of our districts a maintenance supervisor, who, together with a group of maintenance salesmen and engineers, stand ready to assist you with your problems on our apparatus. These men and our regular apparatus salesmen can help you with your parts stocking difficulties, providing data for the correct ordering of parts and taking steps to see that your motors and generators are repaired in the shortest possible time. There are other manufacturers who provide similar repair service. In addition, there are a relatively large number of reliable independent shops. There is no reason why a manufacturer should be burdened today with the rewinding of his motors. He has a big enough job on his hands to produce the goods he is making.

As a word of caution and to emphasize the need for the highest type of maintenance, I would like to call attention to an analysis made by Factory Mutual covering a seven year period. Fires from electrical sources represented 19 per cent of the total, and the greatest percentage of all causes. They ascribe this to two major elements. Lack of proper maintenance and wrong type of equipment in hazardous areas. Good maintenance will clean up many difficulties now blamed on many other operations.

Maintenance Hints

All Line Shafting Checked for Straightness

By Kenton H. Brownlee

A COMPLAINT came into the maintenance department that a certain line shaft, mounted on the ceiling of a room above which was located the plant offices, was causing considerable vibration. This vibration in the office floor caused a lot of irritation to office workers.

The maintenance foreman checked the installation but found it no more out of balance than many other line shafts in the plant. Determined, however, to eliminate the constant complaint he made up three stands with knife edge rollers such as shown in the illustration. Then he balanced a duplicate piece of shafting and one week-end he replaced the shaft, balanced the pulleys and started up the job. He found that vibration was almost entirely eliminated and thereafter he heard no more complaints but did get favorable comments from the office force.

Fig. 1. Here is a length of shafting on the knife-edge rollers

Convinced that he had solved a problem which would aid in the general overall efficiency of his power transmission system he instituted the order that thereafter all line shafting and rotating parts be statically balanced prior to installation. He found that his transmission system ran smoother and required less maintenance.

Sulfur and Oil, Not Molasses, for Elevators

WHEN ELEVATOR guide rails develop noise due to rough spots, the running surfaces should be treated to a coat of machine oil and powdered sulfur. Usually the noise will disappear in a day or two. This is also a good treatment when new cast-iron shoes are installed.

When the guide rails have accumulated a quantity of dust or grit, they should be washed with saturated carbon tetrachloride. The most convenient way to do this is working from the top of the shaft. Standing on the top of the elevator cab, wipe 2 or 3 ft of the rail at a time and gradually work toward the bottom. Change cloths frequently as they soon become gritty and dirty. At the bottom of the shaft it will be necessary to use a ladder to clean the bottom section of the rails. In general a heavy grade motor bearing oil is best for use in car shoe and counterweight shoe wick type guide rail lubricators.

Watch Out for the Wrong Switch

By Thomas Gundel

IN A LARGE midwestern plant constructed during recent years everything electrical was of the latest design. The plant was sectionalized with regard to feeder circuits and the circuit breakers installed in groups for the various sections. Planning placed these circuit breakers at such points capable of adequate protection from productive operations and yet entirely accessible for maintenance and switch operation. A typical installation is shown in the accompanying photograph. Only one thing was overlooked. The switches were not properly labeled for identification of the circuits.

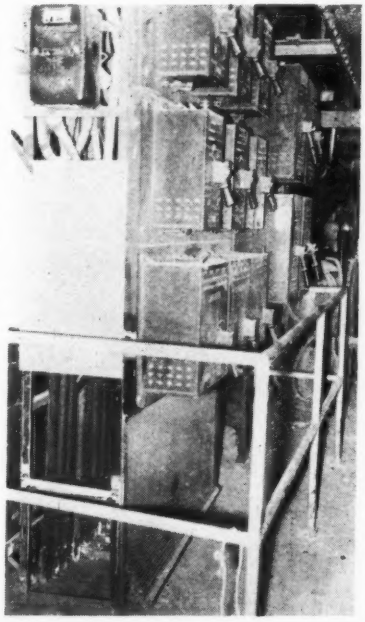


Fig. 1. All the switches are labeled here so that the wrong one will not be pulled

One day while everything was humming industriously there arose a necessity for immediately pulling one of the power circuits. The Electrical Department foreman dispatched an electrician to pull the circuit breaker. He did so but being confused he pulled the wrong one, cutting an important section off from the power supply and causing damage to machine tools, product and a short delay in production.

It was the old story of locking the stable after the horse was stolen, but now each switch is labeled so that there is little likelihood of a repetition of the error.

Painting Radiators

BECAUSE RADIATOR painting is difficult and involves a great deal of preparation work, it is often done in a haphazard manner. Before painting all surfaces should be scraped or sandpapered in order to remove rust and old loose paint. If the paint is to adhere properly all grease should then be removed by turpentine or benzine.

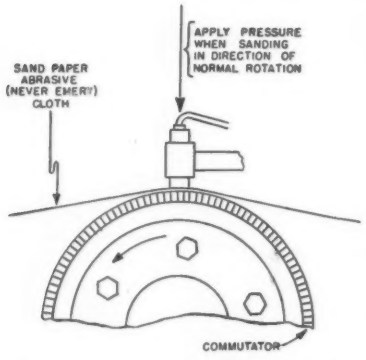
Because radiator maintenance is apt to be put off until the last moment, blistering is a very common difficulty. The radiator must not be heated until the paint or enamel has thoroughly dried and is hard. Turpentine, paint, and cleaners are volatile and explosive. They should not be used near an open flame or while smoking.

Watch Motor Brushes Carefully

AT THE TIME of inspection brushes on commutator and slip ring motors should be checked carefully. Each brush should be removed and dirt wiped from the surface with a dry cloth or grease and oil removed with a cloth moistened with carbon tetrachloride. After being replaced brushes should be free in their holders but not too loose.

These brushes should be long enough to last until the next inspection. If there is any question replace them with a new brush. The new brushes should be carefully ground to fit the contour of the commutator as shown by the accompanying sketch.

That is done by passing a strip of sandpaper or abrasive cloth between the face of the brush and the commutator with the abrasive side toward the brush face. The cutting ac-



This is the proper method to sanding brushes on commutator or slip ring motors

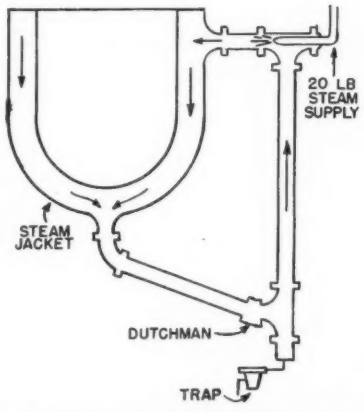
tion can be increased by a light pressure to the brush although this should be done only when sanding in the direction of the commutator rotation. This cutting operation should be started with a fairly coarse abrasive and finished with a fine abrasive.

Steam Circulator Steps Up Cooker Capacity

SOMETIME AGO we had difficulty with the capacity of the steam cooker and solved the problem rather simply in a way that may be of interest to other engineers.

This cooker was nothing but a large kettle, supplied with 20 lb steam and equipped with a steam trap. The heat transfer is adequate for its regular job. However, on an experimental job, in which the production or reaction time was trying to be shortened, the heat transfer was inadequate. For a time the difficulty was corrected by removing the steam trap and replacing it with a weighted check valve. The loss of steam and heat resulting from this practice was not important but the spray from the exhaust created a nuisance which could not be tolerated.

The problem was finally solved very simply by adding a steam circulating line as shown in the sketch. The induction effect of the new steam entering the fitting was sufficient to give a good circulation of steam from the bottom of the jacket around the sides.



This simple steam circulating line increased the capacity of the steam cooker

Questions and Answers

How Are Compressors Operated in Parallel?

Q. Please explain the proper way of operating two single stage compressors. How should they cut in to take load and is there any danger of one working full load continually and the other cutting in and out? The engineer in charge of the plant claims that both compressors cannot be operated at the same time unless the unloaders are all hooked together so both machines cut in and out together.

Detroit, Mich. M. B.

A. In answer to M.B.'s question on compressors in the November issue:

Two single stage compressors can be operated satisfactorily in parallel but the unloaders should be set exactly the same or near as possible. If there is difference in the differentials of the two sets of unloaders, then one will operate at full load and the other one will cut in and out. Of course this operation will not do any harm in any way, but if it is desired to make the compressors carry full load, the best way is to reduce the speed of the compressors so as to just maintain the desired pressure. In this way even though one does cut in and out now and then, both will be delivering near full load. If the load is constant, this can be done, but if the load is fluctuating, then the speed of the compressors must be high enough to maintain the maximum demand and when the load drops, the operation will be as first stated. If it is found that one compressor does all of the cutting in and out, then periodically change the unloaders around so as to produce the opposite results.

Baltimore, Md. CHAS. W. PARKS

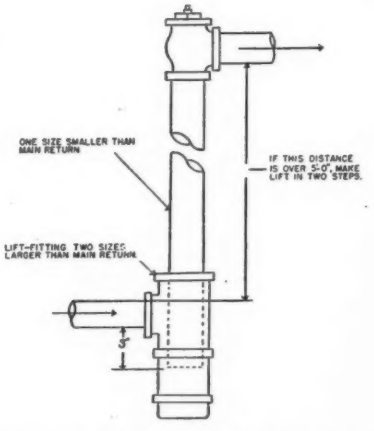
Call for Mr. Pascal!— Why a Lift Fitting?

Q. In locating and relocating unit heaters in our plant I occasionally find the available return line anywhere from a few inches to an extreme of three feet above the heater outlets. When this condition exists I am required to incorporate a so-called "lift-fitting" or "lift-pocket" between the trap and the return line. Every time I pipe in one of these devices, I feel the urge to put in . . .

"a call for Mr. Pascal!!!"

whose hydrostatic law seemingly shows a "lift-fitting" to be superfluous to the point of being a waste of fittings.

However, this past week I discovered the liftfitting pictured in the Hoffman Specialties Co. Bulletin A1A, file 30-C-23, and again in the Skidmore Corp's instructions for installing and using their return line vacuum and boiler feed pumps, from which the details on the attached sketch are taken.


ONE SIZE SMALLER THAN MAIN RETURN
IF THIS DISTANCE IS OVER 5'-0", MAKE LIFT IN TWO STEPS.
LIFT-FITTING TWO SIZES LARGER THAN MAIN RETURN

Sketch by E. E. H. showing how he is required to use a lift fitting; he wants to know why it is needed

I, and my maintenance staff, would appreciate an explanation as to what, where and why anything is gained by the use of a lift fitting; to be specific, I note the following as characteristic of a conventional installation:

Steam pressure—100 psi.

Outlet piping sequence—(1) dirt pocket, (2) strainer, (3) Armstrong trap, (4) a lift fitting in a 3-ft rise to a gravity return line.

Buffalo, N. Y. E. E. H.

How Control Water Level by Pressure

Q. Two wells supply the water in our small plant and I would like to put them on automatic pressure control from the line pressure. At the present time the pumps in the wells are controlled from a float in the tank. The wells are some distance apart and at times one will draw down quicker than the other. With the float controlling the pumps it does the pump harm to start up if there is not sufficient water in the well to provide a good head. I know that this is not a good system but since I have taken over here and would like to make the changes that are obviously necessary I should like to know that the new system will work properly before I start spending money for the equipment.

This is what I would like to know; how to maintain a level between a high and low in the tank by the pressure on the line, how to keep a pump from starting if the water in the well is not sufficient to keep a good head. In what way can I interconnect the pump controls with the pressure control so that only the well with the most water in it will start pumping when the pressure drops to a predetermined point? What equipment will I need for the job?

The wells seem to fill up with sand. Would you advise the use of a sand pump, and how should it be installed to get the best results.

We also have trouble with the tank leaking, could you recommend a paint for the inside of the walls after lowering the water. The tank would still be wet, so perhaps some other good sealing material would be best. The tank is made of cement, cylindrical, 24 ft high, and the bottom is 150 feet above any outlet.

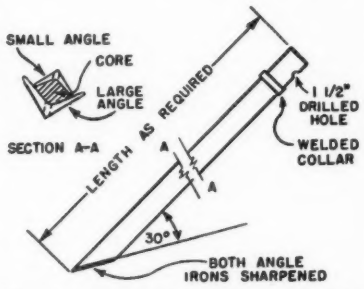
J. H. F.

Quick and Cheap Borings

Q. A new building built during the war settled very badly due to improper footages. The plant is located near the river on filled ground on which the original surface was very uneven. Apparently there is no rock but there is clay, gravel and an undetermined amount of the area filled with trash from some bygone time. The latter in particular gave us a great deal of trouble recently when we were driving sheet piling in order to pour concrete for a new small water intake. We are now considering some additional buildings and want to avoid the settling difficulty we had before. At this stage of the game, however, we do not want to get into anything which will involve considerable cost on a project which may never be carried through. What can we do?

R. M.

A. Considering the amount of money involved in new construction of any kind, you should engage the services of a qualified engineer who has had experience in foundation work. It would seem from your description that a considerable number of borings would have to be made, inasmuch as several buildings are involved. We assume from your remarks about the sheet piling that a small pile driver is available or can be readily obtained. If this is the case, preliminary studies, or borings,



Showing details of method to obtain borings at low cost by using angle irons

can readily be made by means of two angle-irons 10 or 20 ft long depending upon your requirements. These angle-irons should be of different sizes—say a 6 and a 4 in. or a 4 and a 2 in. Inasmuch as there is considerable gravel and it is fairly large probably the largest size would be preferable for your purpose.

These angle-irons should be sharpened as indicated in the accompanying sketch and may be driven separately or together. The latter is preferable because the side thrust on the sharpened points keep them together and minimize the tendency to drift from the vertical. In either case the two angles should be pulled up together; when opened the result is an almost perfect core.

Inasmuch as the pulling sometimes involves considerable difficulty, the tops of both angles should be drilled and fitted with a heavy ring. Each angle should also be fitted with a heavy welded lip or cap. A steady pull on the ring, supplemented by periodic blows upward from the sledge or jackhammer will be adequate to start the most stubborn case. In most cases, a sledge or jackhammer applied horizontally will give adequate vibration to start the piles upward without an excessive pull.

Should 115-V Extension Lights Be Used Inside Tanks and Drums?

Q. Can you tell me whether or not there is any article in any of the National Safety Codes or in the ASME Codes that specifically states the maximum voltage permitted on extension lights for use inside drums or tanks and other similar damp or wet places in a plant, during inspection or repairs?

I have always used 30 to 32 for such internal inspections and would never recommend a higher voltage. Our electrical engineers, however, are recommending 115 for this purpose in a new plant we are about to install. But I am insisting on the lower voltage.

If there are no specific provisions covering this point in any of the codes, what is considered good practice? It seems to me this voltage for extension lights must also be related to the permissible voltage on any electric driven tools that must be used inside a drum or tank. Comments from readers on what they do in such cases will be greatly appreciated.

Mexico R. H. N.

Wasting Light to Save Money

Q. One of the problems which we have not been able to solve satisfactorily, deals with the maintenance of the fluorescent lighting in office areas. These offices are all arranged in one area with a high ceiling. What partitions there are go from the floor to a height of about 7 ft. Individual units are equipped with drop cords which turn the lights on or off with a single pull. In the morning it takes the entire maintenance force answering complaints. This interferes with other work and causes a great deal of general dissatisfaction. Is this complaint common? S. S.

A. Drop cords of the type mentioned are apt to be unsatisfactory for use of this type with fluorescent lighting unless there is a great deal of education. When the average person turns a switch he or she expect light. With fluorescent lighting there is delay. The tendency is to pull the cord again and turn the light off, then decide that the tube is burned out and call the maintenance department.

One plant that had an installation very similar to yours, solved this problem by shortening the cords until they were out of convenient reach and then leaving the lights turned on all the time. The night lighting load coming at an off peak period was obtained at very low cost which was more than offset by the savings in maintenance labor and lamp replacements. Careful inspection was made each evening and any lights which showed a tendency to flicker were immediately replaced. Units which burned out during the day were simply turned off and replaced during the night. If, as sometimes happens, failures in a given bank became too frequent, the entire bank was replaced at once, and the still usable lamps used in other locations where their replacement caused less difficulty and annoyance.

Steam Traps

(Continued from page 47)

turns to locate hot runouts from stubs or risers.

14. **Are you wasting flash steam?** If flash steam from your medium or high pressure traps is being vented to the atmosphere, you are wasting both steam and fuel. Plants with high and medium pressure traps can recover flash steam by one of the following methods:

a. Pass the condensate or flash steam through a heat exchanger such as space heater, water heater, feedwater heater.

b. Discharge the condensate or flash into a nearby low-pressure heating main.

15. **Is all condensate reclaimed?** Loss of condensate by draining it to the sewer or to atmosphere is exceedingly wasteful, unless the condensate is contaminated and would in turn contaminate other water. Pure condensate should be piped back to apparatus requiring hot water.

If there is a long line between trap and unit drained, steam must first condense in it before condensate can reach trap. To prevent steam binding, run a vent line back.

Traps may be installed with dirt pockets at bottom of inlet line just where it enters trap, by running inlet line vertical and use a T at the inlet with a vertical pipe below the trap.

Check valves prevent back-flow of condensate into trap. Automatic thermo drains can be installed in pipe tees directly below inlet of some types of traps to prevent freezing.

There are basically only two kinds of steam trap troubles, which occur with little respect for type or make: (1) Either traps won't drain condensate or (2) they blow live steam.

If the trap fails to discharge condensate

1. Pressure may be too high
2. No water may be reaching trap
3. A bucket trap vent may be plugged
4. Trap body may be filled with dirt
5. Worn or defective mechanism.

If a bucket trap discharges water continuously

1. Trap too small
2. Abnormal water conditions.

Impulse type traps are continuous discharge and when operating right there is always a little flow through them.

If the trap blows live steam continuously

1. Valve fails to seat
2. Trap loses its prime.

If trap operates satisfactorily but steam-using units fail to heat properly

1. One or more units may be short-circuiting
2. Trap may have inadequate air-handling capacity.

Analysis of the foregoing points will show that a large proportion of trap troubles are in reality due to faults in application and installation of traps or faults in the system and not to faults in the trap itself. Finally, observation of the trap discharge gives a good clue to trap performance, hence a test outlet makes it a simple matter to observe this discharge, otherwise the discharge connection must be broken.

Bulletins . . . . Catalogs

(Continued from page 22)

means of photos and drawings and a wash drawing accompanies a description of the coil headers' rugged construction. Physical data are shown by means of drawings and tabular material. A highly useful section of this 28-page booklet is the "Coil Selection Procedure," which presents tables of air temperature-volume ratios, final air temperatures, and others. A worked-out example is presented. American Blower Corp.

ITEM NO. 225

Underpasses, Tunnels—"Manual of Underpasses and Service Tunnels" is the title of this recently issued 22-page booklet. The desirability of underground passageways such as pedestrian underpasses, industrial conveyance, aggregate conveyor tunnels, is explained and each explanatory section is well illustrated with photographs and line drawings. The sizes and shapes of openings, methods of obtaining openings and types of structures are discussed and illustrated. Line drawings and tables show the details and properties of the standard tunnel liner plate, and the multiplate plates. Floor and drainage, lighting, conveying equipment, and brackets are discussed and a list of advantages is given. Armco Drainage & Metal Products, Inc.

ITEM NO. 226

Germcides—This 4-page bulletin describes what is called a modern cold sanitizer which deodorizes, disinfects and cleans. The bulletin points out how the material may be used in institutions and service establishments to cut down bacterial count in food storage lockers, cold storage plants, floors, walls and food preparation plants. The description tells what proportion of the germicide to use for various amounts and also compares this material with formalin, alcohol, boiling water and phenolic solution. Continental Asbestos & Refining Corp.

ITEM NO. 227

Cooling Equipment Guide—The latest guide, No. C.E.47, published on cooling equipment has just been made available by this manufacturer. It embodies descriptions and engineering information on current cooling problems, spray ponds, nozzles, etc. The publication not only includes complete data on all the latest innovations in cooling equipment but also presents a wealth of information of current cooling problems. Santa Fe Tank and Tower Co.

ITEM NO. 228

Nickel Cast Irons—The engineering properties and application of "Ni-Resist," this company's nickel alloyed cast iron, is described in a revised 36-page bulletin. The booklet gives detailed information on the physical and mechanical properties of this cast nickel alloy. Performance under a wide variety of industrial conditions involving corrosion, heat and wear is described. Corrosion data for 400 corrosive media is presented in tabular form. The booklet is completely indexed. The International Nickel Co., Inc.

ITEM NO. 229

Tanks for Industry—The 16 pages in this recently-issued catalog describe the tanks manufactured by this company. The processes followed in making the tanks are thoroughly explored and typical products turned out are illustrated. An exceedingly useful section of the booklet consists of two full-page tables which show corrosion-resistant values of various metals (used in the tanks) when they come in contact with many listed chemicals. John Nooter Boiler Works Co.

ITEM NO. 230

Swimming Pool Equipment—This 8-page bulletin describes the company's complete line of water filtering and treatment equipment for swimming pool installations. Information is provided which will enable the engineer, builder or architect to construct and maintain a sanitary, hygienically safe pool. General construction of the filters is included and detailed descriptions of filtering material, coagulant feed and valving is included. Operation of the system is covered in another section of the booklet. A listing of the pool accessories which the company can furnish is included. Standard pool sizes and a sectional dimension drawing will assist in the construction of any type of pool. Graver Tank & Mfg. Co.

ITEM NO. 231

Enamel Signs—This is a 4-page bulletin which is largely devoted to illustrating various types of porcelain enamel signs which this company has available. Typical signs are "Danger, Explosives Keep Off," "Wear Goggles When Grinding." Physical details of the signs are described and the illustrations are presented in actual coloring. Industrial Products Co.

ITEM NO. 232

Underground Pipe Insulation—This set of data sheets consists of 13 separate sheets enclosed in a large folder. The folder gives a complete description of the company's underground pipe insulation and method of installing; it tells the composition of the material and describes its outstanding features such as high insulating efficiency and strong monolithic structure. Each of the data sheets deals with a separate phase of the construction of conduits and their insulation. The drawings are well done and easy to follow. Universal Zonolite Insulation Co.

ITEM NO. 233

Magnetic Separation Manual—Bulletin 260, 32 pages, covers this manufacturer's magnetic pulley and pulley-type separators for use in separation of metals and protection of machinery by the removal of tramp iron. A description of the operating principles is followed by a 2-page listing of specifications of the unit. Another two pages give "How to Select" information which is accompanied by a large table of selection factors. Tables of capacities, shipping weights, dimensions, etc., and a description of construction details follows this section. Dings Magnetic Separator Co.

ITEM NO. 234

Filter Data Book—All types of oil filters are covered in this 24-page Bulletin 144. Oil filters for sludge removal, water removal, for use with motors and pumps, and in turbine lubricating systems are described. Other filters and mixers for use in oil reclaiming and purifying units and for installation on tank trucks for fuel oil or gasoline delivery are shown. Blueprint illustrations show suggested pipe connections and control valve locations for filter mountings and methods of installation. All types of filters are illustrated and a complete listing of outstanding features of construction and operation are given. Description of methods of acid formation, sludge removal and size of particles removed increase the usefulness of the bulletin. Alsop Engineering Corp.

ITEM NO. 235

Washroom Layouts—Bulletin D637, 12 pages, is comprised of a series of blueprints showing washroom layouts installed in various plants throughout the country. Some of these plants are The Nashville Bridge Co., Electric Boat Co., U. S. Rubber

Bulletins . . . . Catalogs

Co. Other blueprints show typical washfountain roughing-in and typical multistall shower roughing-in. Tables give washfountain capacities and the ratio of showers and toilets to varying number of employes. Bradley Washfountain Co.

ITEM NO. 236

Steel Sash—Bulletin 76B, which was revised September 1947, has been announced by this company. There are 28 pages in this extremely useful catalog and it covers every detail of the windows' construction and presents these details by means of drawings, photos and descriptive material. Methods of manufacture are covered to the extent necessary to show how these manufacturing details affect the windows' construction and features. Drawings, some in two colors picture details. Various uses of the windows in industrial and power plants are shown. Hope's Windows, Inc.

ITEM NO. 237

Wrought Iron—"The ABC's of Wrought Iron" is the title of this recently issued booklet. It tells in non-technical terms what wrought iron is, why it resists corrosion and withstands shock and vibration, how it is made and how it is bent, welded and threaded. Various services in various fields are depicted. A. M. Byers Co.

ITEM NO. 238

Refrigeration—"Dependable Refrigeration," Form 10599 is the title of this new 8-page booklet. Included in the publication are illustrations of the varied uses of Diesel electric sets in ice plants, dairies, fruit storage houses and meat packing lockers. Descriptions of the units being used both as a primary and auxiliary source of power are presented. Caterpillar Tractor Co.

Mark the numbers of the bulletins you wish to receive on the no obligation, no postage card between 18 and 19 and 58-59

ITEM NO. 239

Commercial Films—"Facts for Your Film Folder" is the title of this new booklet outlining the scope of services rendered by this company which specializes in planning, production, distribution and utilization of commercial and industrial film. Film Counselors.

ITEM NO. 240

Oil Clarification—Volume 3, No. 3, of "Clean Oil," is devoted to the complete story of cutting oil purification and coolant clarification, including an explanation of its tangible benefits, methods of application, data on specifically designed equipment and full particulars on typical installations. Honan-Crane Corp.

ITEM NO. 241

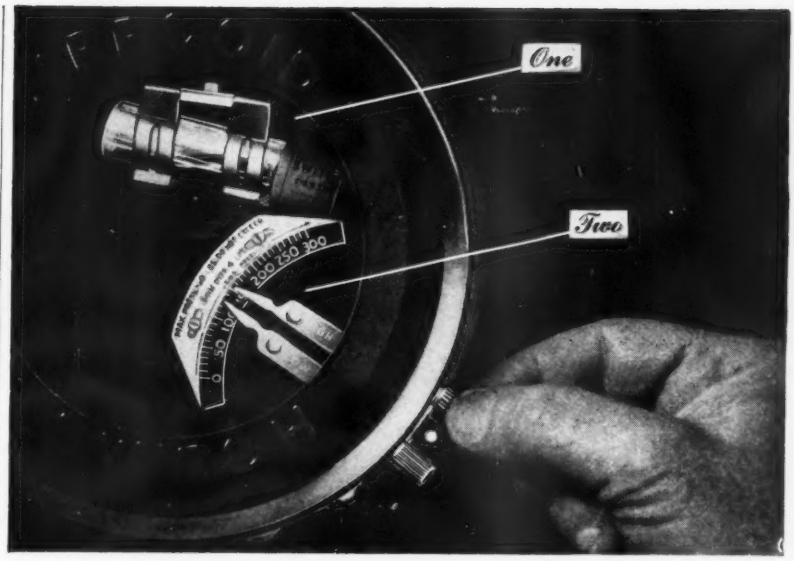
Chemical, Technical Books—Recent bulletins published by this company describe the various technical and chemical books which they have in stock. Brief descriptions of the contents of each book are presented and the prices for the books are given. Chemical Publishing Co., Inc.

ITEM NO. 242

Heat Treating Furnaces—This 4-page folder A-100 describes six different types of furnaces for heat treating from radiant tube fired roller hearth furnaces to box type furnaces. Each one is pictured by a photo and a cross-sectional line drawing and a description of the units is presented beside the illustrations. The Gas Machinery Co.

ITEM NO. 243

Welded Floats Bulletin—Bulletin 746, 2 pages, covers the manufacturer's line of spherical, elliptical and cylindrical floats for applications in the refinery, dairy, cannery, chemical and steam specialty fields. Advantages of construction are described in detail and guides for selection of the proper shape and the proper connections are given. Another useful section is the tabular material which presents list prices, weights, buoyancy and collapsing strength of various floats. W. H. Nicholson & Co.



There are two things to bear in mind about

Mercoid Controls

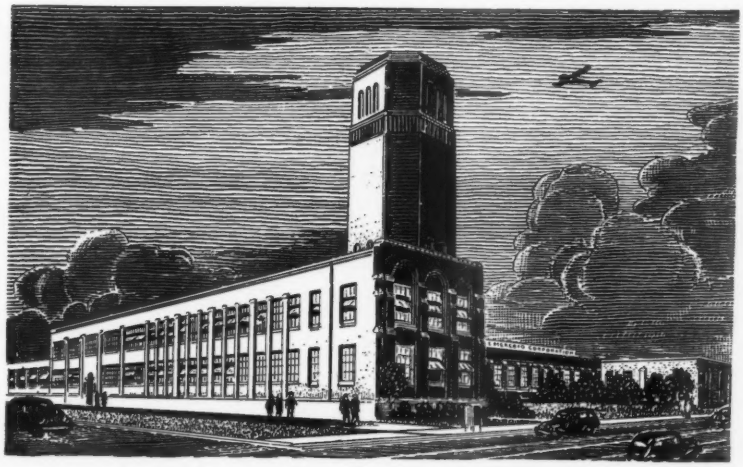
One *The exclusive use of non-corrosive mercury switches. They have proven time and again that no other type of contact compares so favorably from the standpoint of trouble-free service or long years of continuous operation — without showing evidences of a breakdown.*

Two *The simple, accurate and positive means of making necessary operating adjustments. No loss of time or annoying guesswork.*

Engineers readily concede the value of these qualifications, due to the relative functional responsibilities involved in automatic controls

Complete catalog sent upon request

For Heating, Air Conditioning, Refrigeration and Various Industrial Applications



THE MERCOID CORPORATION
MAIN OFFICE AND FACTORY LOCATED AT 4201 BELMONT AVE., CHICAGO

New Products and Methods

(Continued from page 131)

auxiliary heat. If gas burners are added, the garbage destructive capacities are increased about 50 per cent.

It is a steel-cased unit, finished in aluminum paint, shipped complete and ready to operate when connected to a suitable stock or breeching. It is readily portable and may be moved from place to place as changing conditions

require. The incinerator is lined with light weight, insulating refractory material. This lining heats up quickly to insure rapid and complete combustion, and its insulating value is important in indoor installations.

A steel stack of the proper height and diameter can be furnished as optional equipment, and an auxiliary gas burner is available for use where a large proportion of wet refuse is to be burned.

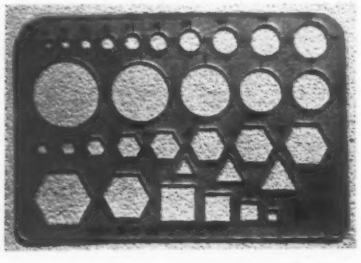
The incinerator includes many important design refinements that are completely discussed in an informative bulletin prepared by the manufacturer.

ITEM NO. 35

Drafting Template

Rapidesign, Inc., presents the new No. 50 Pocket Pal drafting template, designed for maximum usability by all draftsmen, engineers, architects and artists. All the most commonly used symbols—circle, hex, delta and square—have been incorporated in the new template.

Pocket sized for convenience; 3 5/16 in. by 5 in. with rounded corners. Scaled from 1/16 in. up to 1 in. Printing is on negative side to prevent wearing off. Made from 0.030 mathematical-quality plastic. Template cutouts are precision cut with allowance for pencil point. List price $1.00.

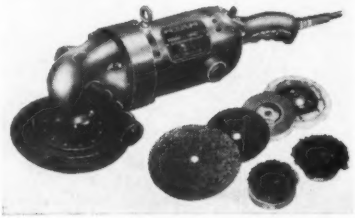


ITEM NO. 36

Versatile Tool

Whirlwind Spinners are among the most versatile, handy tools ever developed. They are said to do a perfect job of sanding, grinding, burnishing, polishing, buffing, wire brushing and glass beveling. They are announced by Holt Mfg. Co.

Whirlwind Spinners come in two sizes —No. 222, medium duty; No. 223 heavy



duty. They are adaptable for use with either 7-in. or 9-in. special Flexholt reinforced sanding disc pads.

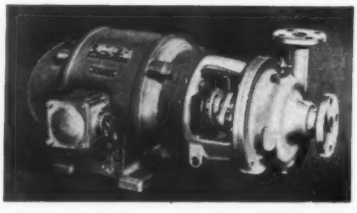
Side handle is detachable to permit either left or right hand operation. Rugged, cut gears, give long life and stamina. Thumb operated switch. Weight, 14 lb; length, not including pads, 18 in. No load speed; 4,500 rmp. Both models come equipped with 25 ft of three-wire cable with plug. A sanding disc wrench is also included. A suspension ring is provided to help reduce fatigue on long jobs. Model No. 222 powered with ½ hp universal motor. Model No. 223, with ¾ hp universal 115 v motor.

ITEM NO. 37

Centrifugal Pump

A new centrifugal pump produced from corrosion-resisting aluminum bronze is the latest product of Ampco Metal, Inc. These pumps are suitable for handling acids, salts, alkalis, etc., where corrosive elements are involved.

First models to come from the production line are the 1½ in. x 1¼ in.,



2 in. x 1½ in. and 2½ in. x 2 in. sizes with others to be announced later. Capacities of the new pumps range up to 240 gpm and the heads to 170 ft.

The new pumps are single stage, closed impeller models. All liquid passages are streamlined for maximum efficiency. quiet operation, and minimum wear. Impellers are factory machined to develop specific ratings. Bearing thrusts are relieved by hydraulic balance.

The complete series of pumps are available in two types: Close coupled and pedestal. The pedestal type pump enables user to connect to any choice drive—electric motor, turbine, or gas engine.

Is there a piece of equipment described here that will solve a big problem in your plant? Do you need more information on it in a hurry? Phone or wire prepaid, The Editor, PLANT ENGINEERING, 53 W. Jackson Blvd., Chicago. Tel. Harrison 0824. Your request will be rushed to the manufacturer's nearest branch office or to his headquarters

ITEM NO. 38

Gas-Air Mixer

A completely new gas-air mixer that permits such features as visible operation has been announced. The mixer is designed to pre-mix any commercial gas—natural, manufactured, or liquid petroleum gases—with air in any desired proportion and in any desired quantity within the capacity of the unit. This mixture is then delivered to the burners under constant pressure.

Available in models of varying capacities, the mixer enables the operator to check the unit's performance by observing piston and valve operation through an inspection window in the air inlet. At present the several models provide mixture capacities from 3000 to 18,000 cfh, with larger sizes planned for future production. Discharge pressures range from 28 to 32 oz, with uniform 3500 rpm for all five models.

With this mixer, accurately controlled combustion mixtures are assured for all types of heating processes. Extremely close temperature con-

ITEM NO. 39

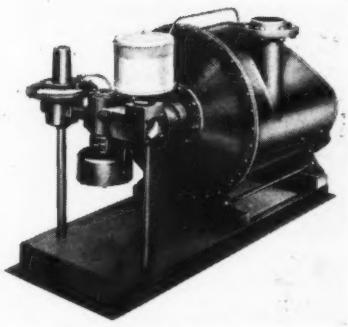
Tar Remover

The Celco Corp. announces the availability of Celco Tank Kleen Formula No. 101, a new type of liquid fuel system cleaner designed to dissolve and eliminate formations of gums, tars and other dangerous binders that are directly responsible for a large percentage of power stoppage and maintenance expense.

Tank Kleen works by reforming all soluble hydrocarbon binders into a liquid which burns with the fuel, while rendering free all insolubles into a colloidal suspension.

The Company believes that Tank Kleen is the first active, non-corrosive gum solvent of its kind with a such diversity of uses. Applied either as a reconditioner or as a preventive, simply by pouring into the fuel tank, it functions equally as well with oil, gasoline, kerosene or fuel oil systems. This includes every type of engine, power unit or fuel burner, from a giant Diesel locomotive to a tiny blow torch.

Specifically, Tank Kleen will restore factory-clean condition to the fuel systems or affected parts of automobiles, air compressors, blow-torches, Diesel engines, locomotives, fuel-oil engines, fuel tanks, gasoline engines of all types and sizes, heaters—gas, oil, kerosene (pot or wick), lead pots, motor generators, saws, welders, etc.



trol, high heat input, practically unlimited turn-down range, high burner pressure and any desired flame characteristics are stated to be features of the new mixer.

Particularly suited applications for this unit are said to be automatic brazing and soldering operations, flame hardening, atmosphere units requiring accurately controlled atmosphere gas, and furnaces utilizing a high rate of heat input. It is announced by Gas Appliance Service, Inc.

Do you want more information on this equipment and its application? Use the no obligation, no postage card between 18 and 19 and 58-59

ITEM NO. 40

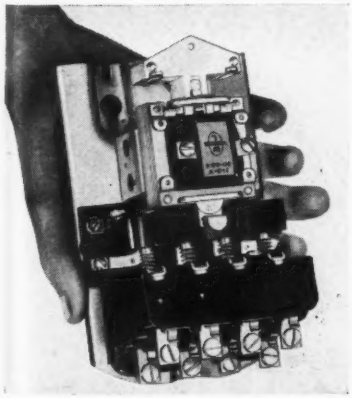
Solenoid Contactors

Ward Leonard Electric Co. announces the development of their new Bulletin 4451 Size 1 a-c Solenoid Contactors. These solenoid-operated control devices are designed for use as main line, reversing or accelerating contactors on a-c motor controllers for machine tools, air-conditioning equipment, pumps, compressors, etc. They are also suitable for remote control of heater loads and tungsten or infra-red lamp loads.

Outstanding features include: Complete accessibility of all parts, compact unit construction, rapid consistent operation, high arc interruption capacity, long trouble-free operating life and simplified installation and inspection.

The solenoid contactors are equipped with double break silver-to-silver contacts. To eliminate threaded or riveted joints in the current path, the solid silver contacts are silver brazed directly to line and load connection terminals.

Available with up to four main poles, these newly designed contactors have maximum ratings of 7½ hp. 440-550 v on 3 phase, 60 cycle circuits. Standard operating coils are obtainable for 110, 220, 440 and 550 v operation on frequencies of 25, 50 and 60 cycles.

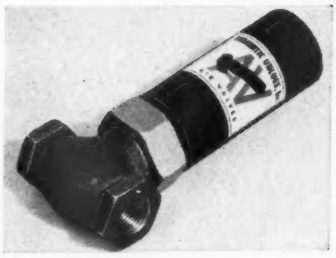


ITEM NO. 41

High Vacuum Valve

A newly designed, direct operated, solenoid high vacuum valve requiring no pilot or other medium for operation has just been introduced. The solenoid valve brings fully automatic control much nearer in industries where high vacuum is used, or may be adapted in the automatic operation of equipment.

The new valve operates on 110 d-c offering instant control over high vacuum systems. It is of poppet design having corrosive resistant internal parts. Resilient synthetic rubber type seating provides a positive seal that makes the valve leakproof. The valve is so designed that no packing is required . . . a factor that assures long life. Airmatic Valve, Inc., announces the valve.



Satisfaction FROM EVERY ANGLE

EASE OF OPERATION IS THE FEATURE I LIKE
NOW WE ALWAYS HAVE ALL THE STEAM WE NEED
SUPERIOR
ITS GUARANTEED EFFICIENCY SAVES US MONEY

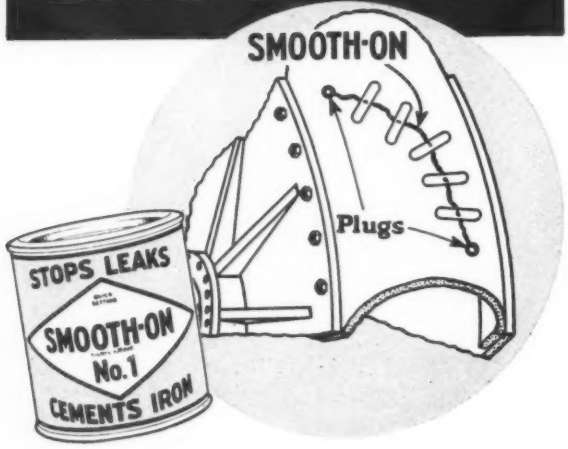
Superior Steam Generators have all the features which you desire. If you are a plant owner, you'll appreciate the efficiency which makes their operation so economical. If production is your responsibility, you can depend upon a Superior Unit to deliver its maximum rating, easily and unfailingly, wherever you need it. To operating engineers, its dependable fully automatic firing with any grade of fuel oil spells ease of operation and a minimum of maintenance.

Available in 17 sizes, from 20 to 500 b.h.p. to operate at pressures from 15 to 200 p.s.i., Superior Steam Generators are factory-tested and shipped completely assembled with a written Certificate of Performance guaranteeing a thermal efficiency in excess of 80% . . . a complete package, backed by undivided responsibility. For complete details, write for Catalog 105.

Superior Combustion Industries, inc.

Factory: Emmaus, Pa.
Executive Offices: Times Building, Times Square, New York 18, N. Y.

For Emergency Repairs
YOU CAN DEPEND ON
SMOOTH-ON



Smooth-On No. 1 Iron Repair Cement is a shop standby for quick, lasting and economical repairs of many kinds. For example:

Even large cracks which you might think would require replacement of the unit, can be repaired with Smooth-On. Most such Smooth-On repairs can be made without dismantling . . . and never require heat.

Smooth-On No. 1 is ideal for many other emergency and routine repairs, like leaks in pipes and joints, loose bolts, and small holes in tanks. Smooth-On hardens like metal . . . stays tight because it expands slightly as it sets.

Get Smooth-On No. 1 in 7-oz., 1-lb., 5-lb., 25-lb., or 100-lb. containers from your dealer or, if necessary, from us.

FREE REPAIR HANDBOOK

40 pages, 170 diagrams, simple, practical instructions for dozens of repairs to plant equipment, pipe lines, structures. To obtain your FREE copy, just fill in and mail coupon.

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Do it with **SMOOTH-ON**
THE IRON CEMENT OF 1000 USES

Plant Engineer's Library

Tubing Handbook

Tube Fitters' Manual, issued by The Parker Appliance Co., Cleveland 12, Ohio. Seventy-six pages; price $1.00.

This is an authoritative handbook on the selection, sizing, layout and installation of metal tubing circuits and it makes available basic data underlying the specialized technique required for the design and quick installation of metal tubing circuits.

Adequately illustrated with photographs, diagrams and charts the handbook covers all phases of tubing systems, with sections on system characteristics, choice of components, sizing, manipulation of flaring and bending tools, circuit measurement and layout and actual installation procedure. Of particular importance are size selection charts based on flow required, pressures handled under varying services, and temperature conditions for meter and instrument systems.

Power Transmission

Principles of Mechanical Power Transmission, compiled and published by Power Transmission Council, Inc., 41 Park Row, New York 7, N. Y.; size 8½ by 11 in.; price $3.00.

This is a book which covers the entire power transmission field, from the economic factors involved in the choice of drive type to detailed descriptions of all types of power transmission equipment; and it does it by means of the clearest possible text and the most excellent of illustrations. For instance, in Chapter 2, "Consideration of Load in Power Transmission Design," the authors first show the necessity for installing a drive of sufficient capacity or larger to take care of any expected, or even unexpected, load demands on the driven machine. An outline is given of the questions which should be answered by an engineer who is designing a power transmission drive.

Following this, the chapter really gets down to the meat of the problem. Examples of possible problems are stated and the authors then proceed to work them out, step-by-step. Every chapter in the book is unusual due to the clear statement of principles involved and the careful, systematic evolution of the complete story up to the more complex problems of design and specification.

Industrial Pressure Vessels

Pressure Vessels for Industry, by Harry M. Spring, Jr.; 259 pp, illustrated; size 5½ by 8 in., cloth binding. Published by McGraw-Hill Book Co., 330 West 42nd St., New York 18; price $3.50.

Here is a complete practical guide to the design, construction, operation, selection and maintenance of pressure vessels for industrial purposes. It was written by one whose practical and up-to-date articles, are familiar to many readers of enginering magazines. In this book he explains how various types of vessels are operated most efficiently, how they are fabricated, how the factors determining maximum safe working pressures are taken into account and the causes for, and remedies of, many defects.

The book begins with a chapter on compressed air systems. Then follow chapters on: pressure vessels for steam and hot-water systems; pulp and paper mills; rubber, textiles and chemical industries; and specialized services. Chapter VIII covers design, pressure and stress

calculations Chapter IX construction and fabrication practices, Chapter X appliances for pressure vessels, and Chapter XI defects, their hazard, prevention and repair. The book is well indexed and has over 200 good illustrations. It covers such equipment as separators, evaporators, pressure filters, digesters, coagulating tanks, kiers, and kier heaters and autoclaves. Accident prevention procedures and appliances for safety and economy of operation are thoroughly presented.

Learning to Weld

Co., Cleveland, Ohio, 32 pages, 5½ by 8½ inches, 83 illustrations including photos and drawings, bound in good quality paper cover, price postpaid anywhere in U. S. A. 25 cents per copy, elsewhere 35 cents per copy.

Learning to Weld provides a simple basic approach for anyone interested in making a start in arc welding. The booklet's purpose is to teach how to weld and to assist in applying arc welding to the repair of broken parts, the hard surfacing of worn parts and the building of miscellaneous equipment. From the information contained in the booklet, the person interested in arc welding gains clear insight into important aspects of the subject on which he may add further knowledge as he desires.

Subjects treated incluude the following: protective clothing and equipment; striking the arc; various welding positions; types of welds; fit-up of parts; procedures for various welds including fillets in horizontal, flat, vertical and overhead positions, butt welds, lap welds, corner and edge welds; welding cast iron; hard surfacing.

There are four pages containing 22 illustrations of typical applications of arc welding in repair and construction. Also included are conversion tables on decimal equivalents and thicknesses of metal in both gauge and inches. There is also a glossary of welding terms.

Principles of Refrigeration

Principles of Refrigeration, by William H. Motz; 3rd Edition (revised); 672 pp; 215 illustrations, 103 tables, 9 fold-in inserts. 6 charts; size 6 by 9 in.; cloth binding; published by Nickerson & Collins Co., 435 N. Waller Ave., Chicago, Ill. Substantially bound in cloth, $8.00.

Since the publication of the first edition of Principles of Refrigeration in 1926, subsequent editions have been revised to include new developments and improved processes, adopted as accepted practice during the interim.

In the original and subsequent editions, the author has had as his objective, the presentation of the elementary and fundamental principles underlying the operation of ice making and refrigerating machinery; the properties and values of principal media used in modern refrigerating apparatus; together with the application of refrigeration to some of its most important uses.

The book will be found useful for beginners in the study of refrigeration, and as a text-book for students in technical schools. It provides information and data for the practicing refrigeration engineer. It is believed that the work will prove of special interest to erecting and operating refrigerating engineers, refrigerating machinery sales engineers, persons employed in building refrigerating machinery, and those employed in ice making, cold storage plants, or other establishments equipped with refrigerating machinery. In general, the work containing the information that it is necessary the refrigerating engineer should know in order that he may have complete and up-to-date knowledge of theory and practice.

The work is in every-day language, and as free as possible from higher mathematics. The method of treatment has been to present a comprehensive treatise on the fundamental principles. With a firm grounding of these fundamental principles, the practitioner is enabled intelligently to design or operate refrigerating machinery. The theoretical and fundamental operating principles are given attention first. This is followed by numerous practical considerations and the application of the fundamental principles to the economic production of ice and refrigeration for various purposes.

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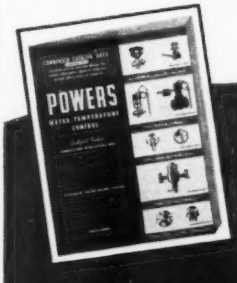

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Plant Engineer's Digest

New Patents

REGISTRATION No. 8196 provides an electrically operated machine for scrubbing and drying floors where liquid cleaners are used on flat surfaces. Switches and levers on the handle regulate its operation. The machine is self-contained, does not employ auxiliary tanks, is lightweight and compact.

In general, the machine consists of a housing which contains the mechanisms. A tubular handle with the

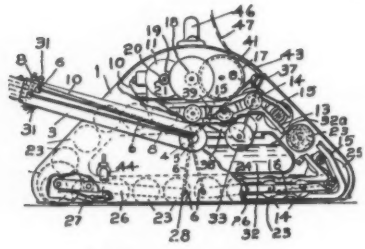


Fig. 1. Floor scrubber

control devices, is pivoted to the housing in a manner which permits the machine to be used under low objects as well as to reverse its direction. The propelling action is proportional to the pressure of the moving parts in contact with the floor.

An endless train of floor contacting-scrubbing rollers provide the cleansing and drying action. Details of construction, positioning of fluid tanks, controls and other features are set forth in detail in the patent.

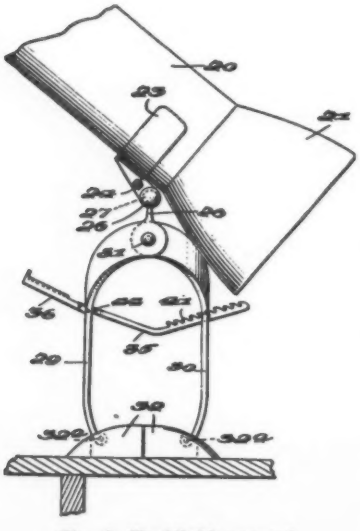


Fig. 2. Flashlight support

REGISTRATION No. 8219 covers a Flashlight case and support for a flashlight of the conventional type. This support may be attached to and form a part of the casing without being cumbersome when the light is in use as a hand lantern. Another purpose is to provide a versatile means for either clamping on a suitable support or acting as a base to maintain the lamp on a flat surface. Many modifications covering the design of the stand and the method of attaching it to the flashlight case, as well as the actuation of clamp members, are shown in the patent.

REGISTRATION No. 8317 covers a liquid cooling apparatus deaerator. The unit is highly efficient in its absorption of heat and because of the manner in which it is insulated there is no pick-up of room heat. It can be used with a standard refrigeration unit.

The unit is preferably fabricated

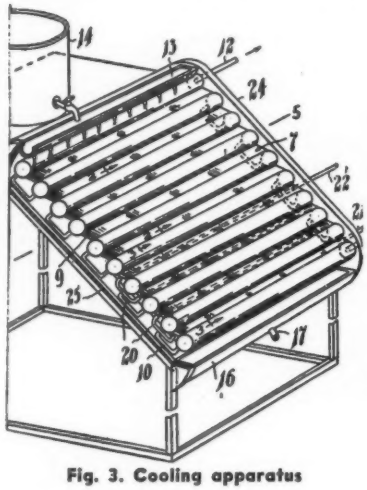


Fig. 3. Cooling apparatus

from a stainless steel. Splashing of the liquid when flowing over the cooling surfaces is eliminated by the slope of the surface. This flow surface consists of a series of tubes through which brine or other suitable cooling liquid is circulated in an upward direction. These tubes are joined by sections upwardly curved so that the liquid flowing over the surface has a tendency to cling and thus set up a retard-flow action.

REGISTRATION No. 8168 identifies a patent designated as a liquid fuel consumption indicator used on internal combustion engines employing a carburetor. Its primary objective is to provide a means by which the fuel consumption per revolution of the engine or per unit of length traveled may be measured. The assembly of the instrument as well as the theory on which the computations are based are set out in detail in the patent. *T. P. Reynolds, U. S. Patent Office in Domestic Trade Digest, October, 1947, a publication of the U. S. Dept. of Commerce.*

Trouble Shooting to Restore Utility Service

TROUBLE is likely to occur on any electric system. When trouble which leads to a service interruption does occur, restoration of the service is the prime consideration second only to the elimination of hazards to personnel.

Troubles on high tension systems usually do not cause customer interruptions since these systems are built for a high degree of reliability with numerous parallel feeds. When major troubles do interrupt service a great many customers are affected and the interruption may be of long duration.

Low tension system includes equipment and lines from the substation to the customers main fuses. Except for network zones, low tension troubles almost always result in customer interruptions since parallel feeds are the exception rather than the rule. A great variety of troubles occur; substation apparatus failures; cable and transformer failures; wires down; transformer fuse operations; blown customers fuse; and a host of others.

Isolation of trouble is largely automatic. All circuits and equipment down to and including 4150 v feeders are equipped with relays which trip the circuit breakers which will clear the fault. In network systems used in congested commercial areas several feeders are tied through transformers to a common low-voltage grid. Relays and breakers are so arranged that a fault feeder will be cleared leaving the low-voltage grid in service. Faults on low-voltage grids are self-clearing.

Individual transformers on radial feeders are fused so that a fault on the transformer or its secondary, that is, low voltage wires feeding individual customers, will be cleared leaving the remainder of the feeder in service. Fuses are required at all service entrances to confine interior wiring failures to the premises. The efficiency of the protection scheme is high. Only about three incorrect relay operations occur per 100 faults.

For fault location work on cables two methods are in general use, meas-

urement and tracer currents. Both depend upon the fact that current will flow through the fault between the conductor and the ground. The measuring methods make use of an electrical device called a bridge. Balancing the bridge gives data from which the distance between the bridge and the fault can be determined. This is generally used only to determine the approximate location of the fault as a timesaver before application of a tracer current fault locator.

This locator causes a current to flow out on the faulty conductor, through the fault and return through the ground. Current is given a peculiar characteristic so that its presence in the cable may be readily indicated by a suitable pickup device. Current will flow in the cable ahead of the fault but no current flows beyond it. The fault is thus located by applying the pickup device at intervals along the cable until two points are found in which the test current flows in one part of the cable but not in the other. The failure is between these two points.

There are three types of tracer current locators. The Lundin imposes a modulated alternating current on the cable. The pick-up device is a coil and an earphone. The Thyratron fault locator uses an intermittent direct current, and the impulse fault locator utilizes a condenser discharge. The pick-up devices for the latter two are indicating meters. *By Thomas L. Hall, in the Public Service News, a publication of the Public Service Co. of N. J.*

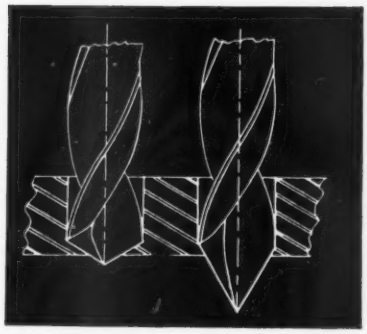
Drilling Phenolic Plastics

MANY FACTORS must be taken into consideration when drilling phenolic materials. These include the type of hole, drill and material; the angle of the drill and the peripheral speed; feeding methods; and the cooling agent used.

Through type holes are more difficult to drill because of the possibility of chipping the back of the hole. If the back of the hole is covered by a screw or washer in the assembly, a slight chip is of little concern. When the hole is exposed, however, a chipped edge is not acceptable and, to obtain a satisfactory operation, may reduce the capacity as much as 25 per cent.

Regular stock steep-fluted high-speed drills are commonly used although in some cases better results can be obtained by plating the drills with hard chrome. Carbide-tipped drills are particularly useful when drilling larger diameter holes and for large scale production on materials which have high abrasive fillers.

Tests conducted with 60, 90, and 118 deg drills indicate that the 60 deg angle is definitely superior in drilling through type holes. These



The 60 deg drill at the right is preferable to the 108 deg drill at the left, especially for drilling holes completely through the material

drills increase the power requirements but feed pressure necessary is lower and allows drilling through with a minimum of chipping. The main factor in chipping is the area of material just where the drill breaks through. As shown by the sketch this is much smaller for the 60 deg drill.

A peripheral speed of approximately 75 fpm is best for drilling. For large scale production a mechanical feed operating at constant speed and pressure is recommended. Reducing the friction between the drill and the material by grinding the drill off center

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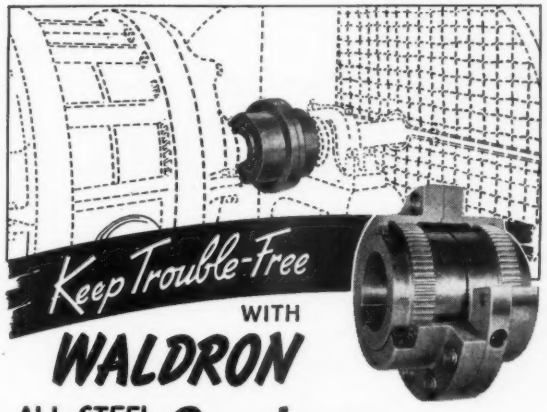

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results in a slightly larger hole but prolongs the life of the drill.

Friction causes the drill to overheat. This is a common difficulty with phenolic materials because of its low rate of heat transfer. Consequently most of the heat must be absorbed by the drill.

It has been found that an increase of 100 to 300 per cent in drilling production can be made by using an air blast. The air blast should be concentrated on the drill in such a position that the air stream will penetrate to the drill tip. *Plastic News, a publication of Durez Plastic & Chemicals, Inc., North Tonawanda, New York.*

How to Determine Compressor Capacity by Split Discharge and Orifice

FOR TROUBLE-FREE operation and maintenance of correct humidity in the refrigerated space, capacity of a compressor for the design running period equal evaporator capacity. Even if coil nameplate data have been effaced, square feet of surface can be readily calculated and, by application of well-known factors, capacity of the coil determined. Capacity of the compressor, on the other hand, decreases as parts wear. Sometimes the valve assembly undergoes substitution or modification.

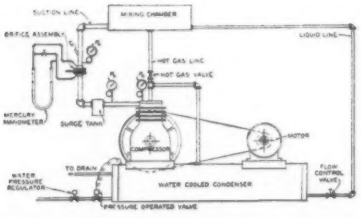

Fig. 1. Schematic arrangement of compressor and valve for measuring compressor capacity by the split discharge and orifice system

This study describes a simple means of determining the capacity of a compressor. The manufacturer can use the method to check calorimeter-derived capacities or to obtain quickly the results of design changes. The system is also recommended for large contractors and service organizations where it would be valuable in determining the efficiencies of rebuilt equipment.

Standard, easily-procurable parts are used in the test assembly. Operating costs are low compared with an electric or steam calorimeter and a further saving comes from reduced quantity of water.

Test Apparatus

Figure 1 show the elements of the system. Part of the hot gas from the compressor is discharged directly into the mixing chamber, where it encounters liquefied refrigerant from the condenser outlet. The two phases blend and resulting cool gas returns via the suction line to the compressor. The multi-hole thin-plate orifice connected by "flange taps" to the mercury manometer, together with the pressure gage P_o and mercury thermometer, are the only instruments required.

The orifice plate is installed between flanges in the suction line. The sizes of the four ports are chosen to cover a full range of capacities from — 40 F to 50 F saturated suction temperatures for compressors from 1 to 3 hp. Three minutes are required to rotate the plate to another port size (capacity range). The suction line may be under pressure during these changes.

Test Procedure

After the compressor is started, the head pressure is approximately set by adjusting the water valve. Suction pressure is raised by opening either the liquid or gas control valves. After the desired suction pressure is set, the required suction gas temperature can be obtained by judicious adjustment of the liquid valve. The next step is the exact setting of the discharge pressure which can best be done by manipulating the water-pressure control valve. Control of the discharge pressure is the key to success with this type of test apparatus, since this pressure affects suction pressure and suction gas temperature, two of the three variables.

When the several pressures and temperatures are obtained, it is a simple matter to close the manometer bypass valve periodically and note the changes in performance of the compressor. After temperatures have reached equilibrium and the mercury column has ceased to fall (or rise), the test data may be recorded. Table 1 shows a typical test sheet. The refrigerant flow rates in column 13 are the results of calculations dealing with the specific volume and the expansivity factor Y. Column 15, Btu per hr capacity of the compressor, contains the results of multiplying the flow rate by the capacity factor. Curves for these relations are given in the paper and sample calculations in an Appendix.

Advantages and Disadvantages

The few significant pressure and temperature readings can be obtained in less than 15 seconds as compared to the several minutes required with the steam or electric calorimeter.

The suction line orifice alone can also be used for a supplementary or check test during the rating of air cooled condensing units.

An electric calorimeter designed for units from ⅛ to 1 hp would cost over $1500 for design, materials, and assembly. The split discharge and orifice system can be assembled of scrap materials in four hours for less than $200. Two orifices, with four ports each, will extend the range to 5 hp.

At this time, refrigeration contractors and serving organizations are meeting the current shortage of condensing equipment by re-operation of old units and, in some cases, desperate substitutions. Normal irreparable wear, interchanged and home-made valve parts, make the catalog ratings of these units unreliable. For rebuilt units, "orphan" units, and non-ordinary installations, this test set-up eliminates in advance one of the variables of refrigeration application.

One of the disadvantages of this system is the absence of a check on results, though theoretically a check is possible. Practically, a small error in reading discharge pressure or temperature has a large effect percentagewise, so considerable technique is required to corroborate the orifice results. *A. D. Sullivan, Chief Engineer, Brunner Mfg. Co. Journal of the ASRE, Refrigeration Engineering, September, 1947, Page 243.*

Table I. Compressor testing—orifice method

Unit...Special — Date...11/13/46 — Room Temp...90 F — Barometer 29.40 in. Hg. 14.4 psia
Compressor...R-2000 — Valve Assembly...F — Flywheel OD...16 — Pulley OD. 4½
Motor Make...Wagner — Hp...2 — Type...RA — Phase...1 — Cycle...60 — Rated Amps...12.4 — Volts...220
Orifice Dia. Test 1 — .220 — Flow Formula... $W = 46.1 \times Y \times (\Delta P/V)^{1/2}$ lb per hr
Test 2,3— .279 — $W = 75.9 \times Y \times (\Delta P/V)^{1/2}$ lb per hr
Test 4 — .338 — $W = 128 \times Y \times (\Delta P/V)^{1/2}$ lb per hr
Note: Surge tank in suction line after orifice.

Compressor						Before Orifice				Across orifice, in. Hg.	Refrig. Flow Rate				Motor				
Sat. suct. temp, F	Pressure, psi		Temp, F			Pressure		Temp, F	Spec. vol., cu ft /lb		Y factor	Lb per hour	Cap. factor	Btu per hour	Btu per watt hour	Volts	Amperes 1	2	3	Watts
	Suct.	Disch.	Suct.	Disch.	Rpm	Psi	Psia													
—40	—11	100	64	197	444	1.7	16.1	64	2.82	8.3	.900	71	60.2	4260	1.33	237	10.5	...	...	1280
—20	0.5	100	66	180	444	9.3	23.6	66.5	1.93	6	.952	127	60.1	7650	4.85	233	11.1	...	...	1580
0	9.2	100	65	172	443	27	41.4	67	1.07	9	.959	210	59.9	12560	6.50	234	11.3	...	...	1915
+20	21.1	110	65	156	441	42.5	56.9	67	.75	5	.985	325	58.4	18920	8.14	231	13.8	...	...	2330

Glass Furnace Temperature Control

HIGHLY EFFICIENT machines and high capacity continuous furnaces used by the modern glass industry are, to a large extent, made possible by perfected methods of temperature, fuel and pressure control.

In feeder operation, where the glass is conditioned and its temperature

stabilized, precise control is of vital importance. A change of 1 F in the molten glass can cause a variation of approximately one per cent in the weight of the finished bottle. Feeder temperature is also a critical factor in determining machine speeds, thus exerting a limiting influence on the maximum gross pack.

Many months of tests under commercial operating conditions has resulted in a temperature control system for furnaces. The original work done at Diamond Glass Co. has been followed by installations at a number of other plants in various parts of the country.

The primary measuring elements are in all cases platinum-platinum-rhodium thermocouples immersed in the molten glass. They may be bare or protected by a platinum sheath and must be installed sufficiently far into the glass to obtain a truly representative temperature. For flint glasses, bare couples are preferred but with opaque glasses such as amber, blue and green, protected couples should be used.

On a given feeder, thermocouples of identical composition are used in the spout and channel. Two controlling instruments are used, one on the spout temperature and the other on the channel temperature. Should the installation involve a rear channel a third thermocouple is required and a selector switch provided. This switch when depressed switches to the rear channel couple so as to give a momentary indication of the rear channel temperature. Upon release the switch automatically reconnects the instrument to the controlling couple. This provides the operator with a convenient method of spot checking the rear channel temperature. The machine operator also has a signal light station which enables him to take full advantage of the extremes in feeder capacity.

A manual by-pass control is also provided to aid the operator during shutdowns or repair periods or when starting up a new feeder. This permits manual control from the instrument panel, and obviates the necessity for handling by-passes around the control valves.

Control system makes it practical and possible to operate at lower stable temperatures, thus permitting higher machine speeds and a corresponding increase in gross pack. The temperature is held under firm control continuously a factor of prime importance during job changes when it is necessary that the feeder be stabilized at the new operating temperature as soon as the molds are changed. On some jobs changes have been observed that this time can be reduced to as low as 20 min with feeder control whereas under manual operations several hours were required. *By John R. Green and E. A. Murphy in Instrumentation, a publication of the Brown Instrument Co.*

Drum Sizing for Wire Rope

ON MOST WIRE rope applications the size of the sheave or the drum in relation to the size of the rope affects the service that the rope will give. This is as important as any other single factor. The relation of the sheave and rope or the drum and rope is called the sheave rope ratio or the drum rope ratio. By this is meant the tread diameter of the sheave in inches divided by the diameter of the rope in inches. Thus a 1 in. diam. rope operating over a 16 in. diam. tread sheave will have a sheave rope ratio of 16.

The larger the sheave or drum the longer will be the rope life. This is particularly true when the sheave or drum rope ratio is small. A 6 by 19 rope with a sheave rope ratio of 16 will show a relatively large increase in life of the rope for a small increase in the sheave diameter. This tapers off but up to a sheave ratio of 33 the per cent increase in rope life is the same as the per cent increase in the sheave rope ratio. Above 33 the per cent increase is less and after reaching 100 there is little increase in the rope life by increased sheave diameters.

On any piece of equipment the overall economy of the machine determines the sheave and rope diameter and not merely the fatigue life of the wire rope. It is true that wire

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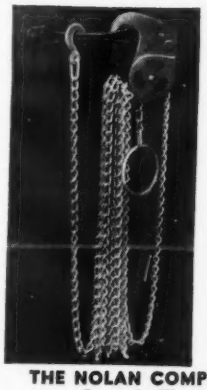

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Usual sheave and drum sizes used for wire rope in various applications

EQUIPMENT	SHEAVE AND DRUM SIZE
Logging Equipment	10 to 20 times rope diameter
Portable Excavating Equipment	16 to 36 times rope diameter
Oil Field Equipment	12 to 45 times rope diameter
Overhead Electric Traveling Cranes	30 to 40 times rope diameter
Passenger and Freight Elevators	40 to 60 times rope diameter
Mine Hoists, Incline Slope	48 to 80 times rope diameter
Mine Hoist, Vertical Shaft	64 to 110 times rope diameter

rope is an important replacement item on most rope using equipment but the factors of economy in first cost, competitive size, and in some cases portability of the equipment, are the governing requirements.

Increasing the drum diameter often introduces a number of problems which might affect the entire machine. For instance if the load and rope speed are fixed, the larger drum means a change in gearing between the drums and drive and often necessitates the addition of a counter-shaft, increased weight, size and cost are other problems that arise.

Wire rope manufacturers are often called upon to specify the size of the sheave or drum to be used with their rope. To arrive at this in terms of rope alone without taking into consideration the purpose of the equipment to which it is used, might result in sheave or drum size that is impractical. There is no rule for establishing sheave or drum diameters that can be applied universally except the general statement "make the sheave and drum diameter as large as feasible". Common practice for different applications are indicated in the table. *By William C. Russell, Chief Wire Rope Engineer, Macwhyte Company, From Rope-Ol'ogy, a publication of the Macwhyte Company, Kenosha, Wisc.*

Materials Handling by the Electric Industrial Truck

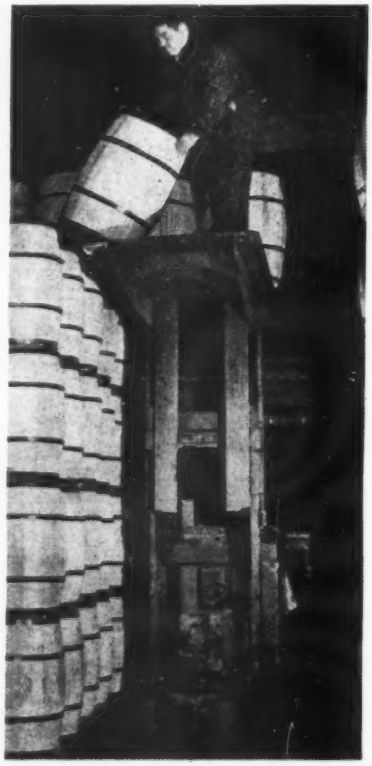
MATERIAL HANDLING adds nothing to the value of the merchandise or product but only adds to the cost of its production. That is why industrial engineers consider it to be one of the few remaining operations in which it is still possible for industries to cut production costs drastically. The mechanized industrial truck ranks high in the list of aids on which management can call to achieve the goal of higher production at lower cost.

Power truck is not a war baby but it took the demands of war to forcibly bring home to industrial management the full value of this equipment. The modern industrial truck with one man operation can accurately pick up, move, position and deposit, bulkier and heavier loads in faster time, with greater safety to man and material than any known material handling device.

It provides mechanical handling for production and shipping operations which cannot afford fixed systems of handling. A good floor plus battery operated trucks provides low-cost, flexible, dependable system susceptible to infinite varieties of plans and rearrangements of machines, storage areas, warehousing areas, and loading docks.

To be used most advantageously it should be integrated into production plans which call for conveyors for long runs of repeated operations. It must compliment the overhead crane where awkward loads of great weight are involved. It must supplement gravity chutes in multi-story warehouses and factories. In many plants, however, the entire system will be economically built around skid-platforms and fork-truck pallet operations.

Early types of the industrial truck with a fixed platform was followed by a lowlift platform design. This has the advantage in that it can be maneuvered under a skid which has been manually loaded. The loaded skid can then be lifted clear of the floor, moved to another position, and deposited and may be moved from job to job without waiting for manual loading of platform.



Battery-powered tractor moving a train of merchandise-loaded dollies

The next step was to make a truck that would lift the load high enough to permit tiering the pre-assembled loads. This is the so-called highlift platform truck. At first this was less than 6 ft. Advances, however, now make it possible to tier loads at heights as great as 11 ft. Special telescopic devices have been developed to increase this height and enable loads of 5 tons to be lifted and placed at extreme heights by one man.

Contemporary with the lowlift truck was the development of the battery-powered industrial tractor. This makes possible the assembly of loads on relatively low cost platforms on wheels, commonly known as live skids, trailers, buggies, flats or dollies. They are moved in long trains over long distance on piers, warehouses, railway terminals and large factories.

A power truck can make such huge savings in comparison to the cost of manual handling that it need not be busy continuously to show a profit. In many instances a truck having no more than an hour's work a day can pay for itself in a year.

As an illustration, assume a 2 ton lowlift platform truck to move material over a distance of 100 feet. With the material piled on skids in 2 lots, the truck working continuously will handle this in 53 loads or at the rate of 106 per hr. If hand truckers handled an average of 350 lb per trip at 20 trips an hour the rate would be 3.5 t. per trucker per hour. One machine trucker would thus do the same amount of work as approximately 30 hand truckers.

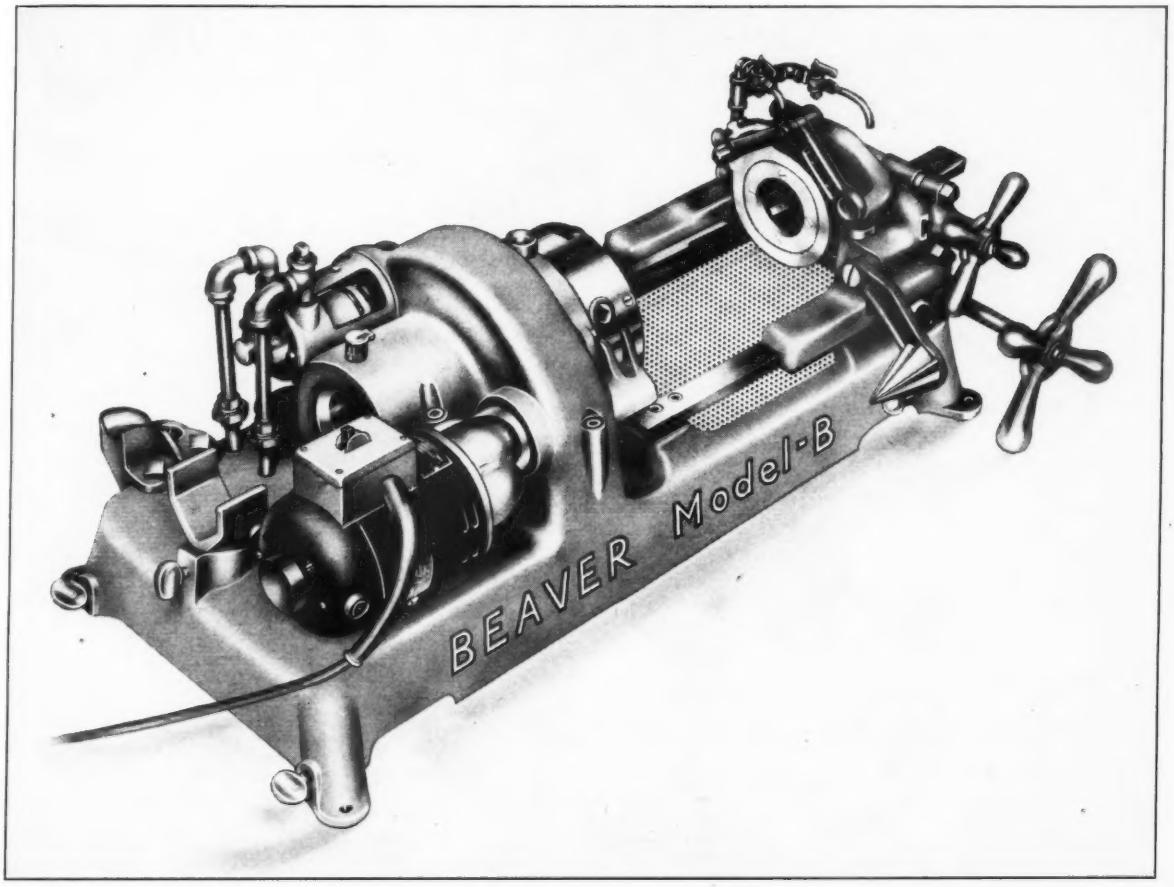
Through the use the Annual Operating Cost Summary Form developed by the Electric Industrial Truck Association it has been established that, based on present prices for equipment and power, the cost of owning and operating a truck 8 hr a day, is approximately $1.91. Figuring the wages of the truck operator at $1.00 per hr, gives, for only 1 hr operation, a cost of $2.91. For this amount 106 t. of material was moved 100 ft, that is 2.75 cents per ton or per 100 ton-ft.

Hand trucking costs will depend upon the truckers wages. Taking this very conservatively as 50 ct an hr, the cost of movement 3.5 t. would be 14.3 ct. a t. To move 106 t. the cost would be $15.00 as compared with $2.91 for the electric truck.

Assuming the truck was operated 7 out of 8 working hours, total movement would have been 742 t. at a total cost of truck operation and labor of $8.91, or, a fraction more than 1 cent a ton. To move the same tonnage manually under the same conditions would cost 14.3 ct. per t. although the cost would have been spread over a period of 212 hr or 26.5 working days—the total cost $106.

By Charles F. Kells, Electric Industrial Truck Association, in the Edison Electric Institute Bulletin, September 1947.

THE BEAVER MODEL-B A Highly-Efficient Portable, Utility 1/8 to 2-inch Pipe and Bolt Machine of Exceptional Merit



The BEAVER MODEL-B is a compact, portable, utility pipe and bolt threading machine embodying many advanced mechanical features heretofore available only on higher priced machines. Note the following specifications: Complete range, 1/8 to 2-inch pipe; 1/4 to 1 1/2-inch bolts. Cuts and threads up to 8-inch pipe with drive shaft and geared tools. Rack and pinion feed. Right-hand operation . . . like a lathe. One piece cast steel-iron base and cap. All-steel geared universal Cushman chuck . . . with safety automatic chuck wrench ejector. Hinged full-range reamer, 1/8 to 2-inch. Ball-bearing, self-centering wheel-and-roller cutoff to cut either pipe or solid rounds. Automatic knife cutoff optional, same price. Quick-opening, fully-adjustable dieheads . . . with high-speed steel dies. 186 different kinds and sizes of dies available from stock. Automatic gear-driven oil pump. Gears fully-enclosed and run in oil. Adequate motor ventilation. Choice of 110 or 220 volt universal reversible motor . . . for AC or DC current. Portable stand with 17-inch steel wheels available. Weight approximately 280 lbs. Sold by leading supply houses everywhere. Price, 1/2 to 2", $389.40.

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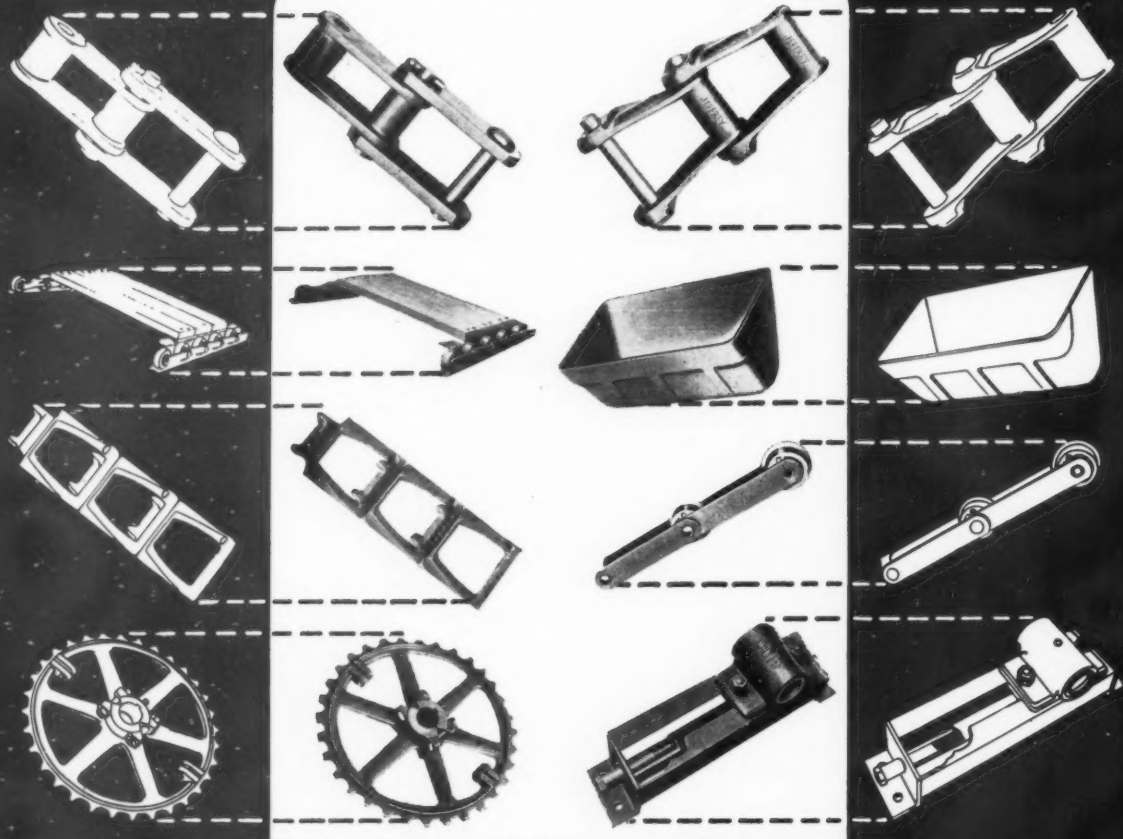

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